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FIRST BOOK

IN

PHYSIOLOGY:

WITH

ANATOMY,

AND

THE LAWS OF HYGIENE.

BY

JOHN B. NEWMAN, M.D.,

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ILLUSTRATED WITH ENGRAVINGS.

STEREOTYPE EDITION.

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1851.

Look round our world; behold the chain of love
Combining all below and all above.
See plastic nature working to this end;
The single atoms each to other tend;
Attract, attracted to, the next in place
Formed and impelled its neighbor to embrace,
See matter next, with various life endued,
Press to one center still the general good.
See dying vegetables life sustain,
See life dissolving vegetate again;
All forms that perish other forms supply
(By turns we catch the vital breath and die),
Like bubbles on the sea of matter borne,
They rise, they break, and to that sea return.—Pope.

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PREFATORY.

JOSEPH MCKEEN, ESQ.:

DEAR SIR—An author who offers to the public a new work on a subject about which many others have written, betrays by that very act a secret consciousness that he has done better than his predecessors. That there are books of this character now in the field with just claims to popularity can not be denied; but it is equally true that none are perfect, and there is room for improvement even in the best. Having paid special attention to the subject, and taught it for many years with acceptance in the manner he now presents it, the author felt that he had gained a little additional light, which he takes this opportunity of placing in a conspicuous position, that its rays may shine on others besides the members of his own classes. And he does this with the hope that a sufficient number will be found to agree with him as to its value to give it the award of success.

It has been often observed that a traveler can describe the scenes he has visited better from conception than perception, from memory than while actually seeing them. The most striking objects, those which give individuality to the scene rising first in his remembrance to be succeeded by the more minute and unimportant. By this means the order of nature is observed, and a transfer of the impressions on the mind of the narrator is made on the mind of his reader. The same plan is adopted in the bird's-eye view presented in this work. The subject is first taken as a whole, the intimate connection of organ with organ shown, particular portions being now and then dwelt upon, that were before involved in obscurity, or relating to which there was an unusual degree of interest.

Physiology is now defined to be the study of the phenomena exhibited by the laws of life through the medium of organization, when acted upon by healthy influences. To give a correct idea of their mode of working, it was necessary to explain what the laws themselves were, and point out their distinction from the forces of chemistry and mechanics. Anatomy and Hygiene accompany the Physiology, and illustrations have been taken freely from experiments on the lower an-

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imals whenever they tended to elucidate the subject. There is an ample number of facts cited to sustain all the positions assumed, and the pupil is thus enabled to prove all the assertions as he proceeds in his lessons. An endeavor has been made to "magnify" the office of Physiology by showing its intimate connection with Mental Philosophy and its importance in Education.

This work is complete within itself, and designed to present a faithful outline of elementary Physiology, so that if none other should be studied, a satisfactory knowledge would still be obtained by the pupil of his own body and the laws that tend to preserve it in health; but it is hoped to do more than this, to awaken emotions of pleasure and interest sufficient to produce a strong desire to understand more thoroughly that which is of such moment to all, in every rank and occupation. Should it succeed in this, it will aptly prove itself what it really is—the forerunner of a larger work on a more extended scale, both as to illustration and all necessary minuteness consistent with its popular object.

Nearly every chapter presents a distinct view of a separate system, the harmony of each with all the rest being carefully kept up. These chapters may be conveniently divided into lessons for school recitations, although the unity of the subjects did not allow such division in the book. To prevent misunderstanding, it may be observed that wherever the word *nature* is introduced in the sense of an intelligent power, the Author of nature is meant. With the earnest desire that the work may meet your approbation and that of the Parents and Teachers of our country, I remain,

Your old pupil and sincere friend,
JOHN B. NEWMAN.

HARRODSBURG FEMALE COLLEGE,
Dec. 28th, 1850.

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THE

PRINCIPLES OF PHYSIOLOGY.

CHAPTER I.

THE PRINCIPLES OF PHYSIOLOGY.

High Rank of the Ancient Physicians—Esculapius and his Family—Writings of Hippocrates—Their Neglect and the Consequences—Revival of Literature and its Effects—Modern Errors and their Refutation—Atoms of Nature—Two Sets of Laws—Builders-up and Pullers-down—The necessity of Opposition—Example of Two Seeds—The Living Seed—Life is a forced State—Causes of Death—Laws of Hygiene—Seven Properties of the Life-Power—Vital Affinity—Vivification—Mobility—Instinct—Excitability—Growth of a Seed—Plants have five Properties—Animals seven Properties, and why—Distinction beetwen the two Kingdoms—Sympathy—Sensibility—Physiology—Pathology—Conservative Power—Experiment with the Dormouse—Chilled Hands and Feet—Restoration of Frost-bitten Parts—Means of preventing Frost-bites.

Kings were the physicians of the ancients, and their teachers in medicine; and of such importance, in olden times, was a knowledge of the human body regarded that it formed the last and holiest rite of the magic taught in the Egyptian temples. The people of those days, not satisfied with giving their eminent doctors the highest places on earth, went so far as to deify them, as they thought, by worship after death; and it was in this manner that Esculapius, a surgeon of exceeding eminence, became the god of medicine for the Greeks. His princely descendants, for many generations, pursued the profession of their ancestor, and were held in almost equal reverence. That they deserved much of this honor is evident from the pains they took in acquiring information ; they had a record containing all that was known of the science up to their day, to which each prince in turn added an account of his own observations and experience, together with what he thought valuable in the practice of others ; these books were treasured with jealous care, and far beyond all their other possessions were looked upon as the most precious heirloom of the royal family.

Hippocrates, the twelfth, or, as some say, the eighteenth in descent from Esculapius, stands next to that god in history ; statues and altars were erected to his memory ; incense was regularly burned before his image, and we are informed that he shared with Plato the title of *Divine*. So great was his fame that Xerxes, the monarch of Persia, sent for him during the plague, and offered honors and magnificent rewards for his services ; but the "wise old man of Cos" (the island on which he lived) refused, returning for answer that his country had the right to his services, and that he would not leave it in times of danger ; Xerxes was so much enraged that he vowed vengeance against him. He is called the Father of Medicine because he laid the foundation of the science, and opened its avenues to all by publishing the records of his family, after carefully revising and adding his own experience to them. It is said that there were seventy-two books made, but many of these have been lost. The remnants that have come down to us can not be too highly estimated ; they give the results of careful study of the system in health and disease by the greatest minds of antiquity, and as they accord with similar observation at the present day, show that the constitution of man, and the laws of cure, were the same then as now. With the exception of some few errors, they display an extensive and surprising knowledge of anatomy.

For many succeeding ages this immense store of valuable learning was neglected by the majority of medical men, who chose rather to speculate than observe nature. Imagination filled the place of reason in the mind, and the schools, in consequence, taught a collection of absurd and confused hypotheses. In proportion as the teachers wandered from the writings of Hippocrates, they deviated from truth, and thus system after system was presented to the world, to flourish a little time and then make way for another to pursue the same course. The physiology current in those times was justly stigmatized by those competent to examine it as a mass of ingenious guess-work, totally without foundation, and utterly unworthy of the time and trouble spent in acquiring it; hence the neglect into which it fell for many centuries.

At the revival of literature, when every branch of science was prosecuted with the most eager desire, the study of man was not forgotten. A host of mighty names labored earnestly in this department, and astonished mankind by their brilliant discoveries. For a long time, however, the facts thus presented, although very important in themselves, were isolated and needed connection; but at length the period arrived when they were numerous enough for generalization. It was about the beginning of the eighteenth century that physiologists began to perceive that life was governed by laws peculiar to itself, and that some other principles besides those of chemistry and mechanics must be resorted to in the explanation of its phenomena. The true principles were then deduced, the cement of theory united the stones of facts; the temple, whose modern foundations had been so long in laying, had its superstructure rapidly erected, and its glorious proportions gladdened the eyes of beholders from its acknowledged location on the hill of science.

Regarding the opportunity as favorable, the students of Hippocrates presented the claims of their master, whose writings were then attentively perused, and the philosophers found, to their surprise that, to a great extent, they had been merely engaged in verifying the truths proclaimed thousands of years before. Thus doubly fortified, Physiology at the present day takes a lofty and assured position, boldly rears its standard on the accumulated experience of ages, proclaiming that the Old and the True are one, and that there is both safety and certainty in medicine.

The rubbish of exploded errors is not yet, however, entirely removed from the precincts of the temple; some of it has been employed of late years by many of the French and German writers, who, dissatisfied with being forced to study the *phenomena* of life without the power of making the SUBTILE ESSENCE, producing these phenomena, tangible to their senses, have utterly denied the existence of a vital principle, introducing in its stead the magnetic force as being the most subtile agent they knew. In doing this they have not only disregarded the principles of philosophic reasoning, but forgot besides that they could tell as little of the *nature* of their substitute as of the life-power. "This uncalled-for skepticism," says Dr. Good, "has involved them in a dilemma from which it seems impossible for them to extricate themselves: I mean the existence of powers and faculties without an entity or substratum to which they belong, and from which they originate. We see them not only employ terms that have no meaning, but also laws and powers without any source, a superstructure without any foundation, effects without a cause." It is enough that the physiologist knows as much of the nature of the life-power as the chemist does of his affinities, or the mechanician of gravity. In our present state of being, all endeavors to pry into first causes or essences are useless, the phenomena alone in all cases are the only proper subjects of our study, and by trying to obtain more, we not only lose time, but in some cases, every thing else. As many errors of this kind have crept into our books, it is well for the student to be guarded and ready for their exposure.

Chemists inform us that there are in nature some sixty elementary substances, and that of these all things, animate and inanimate, are composed. The interior of the solid structure of the earth as far as man has penetrated, its layers from the quartz upward, its seas and oceans, the vegetation that clothes its surface, and the living tribes that inhabit land, air, and water, all owe their material constitution to the combinations of these sixty atoms.

Passive of themselves, and blindly obeying the strongest power that acts upon them, the atomic particles furnish means for the operation of two sets of laws, diverse in character, and working in opposition. These are the chemical and mechanical forces, and the VITAL PRINCIPLE.

The chemical and mechanical forces are the destroyers of all things, by inducing perpetual change in combining and separating the atoms. Their chief mark is instability. Were the earth solely under their influence, all would be barrenness and desolation. By their means the stately palace, alike with the peasant's hovel, crumbles to decay; the proudest efforts of man's architectural genius sink to ruin, and even the everlasting hills, as they are vainly called, share the same fate. They have been aptly termed the Pullers-down of nature; their study belongs to the chemist and natural philosopher, while that of the life-power pertains exclusively to the physiologist.

In contrast to the Pullers-down rise the Builders-up of nature, or the vital power. The latter take the atoms and construct with them forms of utility and loveliness. To them the animal and vegetable kingdoms are indebted for their very being. As long as they remain in the habitations they have erected, the destroyers are kept at bay, but the moment they depart, the enemy takes possession, decay and corruption supervene, beauty gives place to deformity, and dust returns to dust.

Yet, in the mysterious and wonderful arrangements of Providence, who makes one cause produce varied effects, the Pullers-down are absolutely necessary to the active working of the Builders-up. The Destroyers serve the Constructers in two ways: first, by stimulating them; and secondly, by resolving the organic compounds, after death, to their original elements, so that the vital forces may find them in a fit state for recombination.

The difference in the mode of operation of the two opponents may be shown in the case of two seeds, one of which has had an electric spark passed through it to destroy its vitality, and both then placed in a warm, moist situation. The dead seed, placed where the influences most favorable for decomposition—heat, air, and moisture—can act freely upon it, soon decays, while the living one, in exactly the same circumstances, rapidly sprouts, increases in size, and soon rises above the ground in which it was buried, displaying its green foliage and beautiful flowers as emblems of victory.

The developing seed contained a living inhabitant, which, while unexcited, would have remained quiescent an indefinite length of time; in proof of this, melon seeds have sprouted and produced delicious fruit after having been dried two hundred years, and corn has been raised by planting grains taken from a mummy in whose spicy envelope they had remained, undisturbed, thousands of years. The little being taken from its place of rest was surrounded by the Pullers-down, who endeavored to force from it the atoms of its case: it not only refused to yield them, but, roused by its struggles for existence to a high degree of excitement, seized other atoms, perhaps the very ones just set free from the dead seed—compelled them to obey its orders, and with them built its house and formed its compounds. Incessant attacks kept its powers at their utmost stretch, and the contest continued until it had reached maturity, attained its peculiar perfection, and fully served the purposes of its creation.

We have thus seen that life, once roused to action, is a forced state, and can only be supported by perpetual stimulation. But it may be asked here, that as the life-power is present, and the opposition never ceases, why does the plant or animal finally die? By what influence is it induced to leave its habitation and make room for successors? The law of habit is the answer. Whatever has once acted upon the life-power, must have increased energy a second time to produce a like effect to the first; for each succeeding effort greater concentration is required, until at last, no matter how intense that particular stimulus may be, it utterly fails to produce any impression.

King Mithridates, to prevent being secretly killed by his enemies, in the days of his prosperity so habituated himself to the action of poisons, by beginning with small doses and gradually increasing to larger ones, that all of them were at last unable to injure him in the least degree, so that when he fell into adversity and lost his kingdom, he tried in vain to commit suicide by their means, although he drank freely of the strongest and most subtile kinds. It is in the same manner that the various chemical and mechanical forces finally exhaust their influences on the life-power, which, failing at last to become excited, loses all control over the atoms, the forced state ceases, and death ensues.

It is the object of the laws of Hygiene to direct the proper kind and quantity of stimuli for the life-power, so that its excitement may be neither too feeble nor too intense, that the vital flame may not burn too languidly on the one hand, or too brightly on the other. Want is as injurious as excess, perhaps worse, for "it is better to wear out than to rust out." It can easily be seen from this how alcohol and tobacco, in their various forms, shorten the term of existence on earth. Even the use of animal food, which is more stimulating than vegetable, does the same. Before the Flood, the products of the vegetable kingdom were the sole food, but afterward permission was given to use both kingdoms for sustenance, and this may have been one of the means employed to limit the time of sojourn here, from many centuries, to the brief span of three-score years and ten.

By studying the phenomena which the vital principle, while in connection with matter, presents to our view, we are enabled to distinguish as belonging to it seven distinct properties, or different modes of working. These are known as VITAL AFFINITY, VIVIFICATION, MOBILITY, INSTINCT, EXCITABILITY, SYMPATHY, AND SENSIBILITY.

Vital Affinity is the agent of organization; by its means the atoms of living structures make their first combinations. It is the direct opposite of chemical affinity, with which it is constantly at war; the latter always combines the atoms in multiple proportion, and in limited numbers; while the former uses them in all proportions, and in any quantity. Some years since several chemists agreed to compound milk after having, by analysis, discovered its composition; they put the requisite ingredients in a crucible and applied heat to it, but the result greatly disappointed them—it was mostly a little water and gas, and the only useful effect produced by the experiment was a lesson in the difference of the affinities under their control and that of this agent of the life-power.

The most active working of vital affinity is seen in plants, where we can observe it forming, with the aid of little else than charcoal and water, the numberless varieties of the vegetable kingdom. Animals, whose elementary composition is nearly the same, can, as a general rule, only subsist on the atoms when presented in an organized form; hence their vital affinity does not seem as powerful.

Vivification is the name given to that process by which matter is thoroughly permeated with life, as when the atoms have undergone all the stages of digestion, and become finally converted into arterial blood.

Mobility imparts the power of motion; it enables the sap to course through the tree, the blood to circulate through the body, the mimosa to shrink, and the muscles to contract.

Instinct, in this sense, acts as a sentinel, prevents danger, and gives aid in cases of emergency. Like all the other properties, it is modified to suit the peculiar needs of each individual, whether plant or animal. Owing to it, the strawberry sends out runners for water when none can be procured immediately around it. The same property gives the flowers notice when to open at certain hours of the day best suited to the ripening of their pollen, also when to close before rain or bad weather injures them, and thus foretell to the attentive observer the approach of storms. In animals, it is noticed, among other things, by the throwing out of the hands unconsciously when in danger of falling, so as to break the violence of the shock, and also by forcing to the surface of the body collections of matter formed in various parts, whose presence, if discharged into the internal cavities, would occasion sickness and death.

Excitability is the mainspring of the entire living movement, and of course the most important of all the properties. It is on this that the chemical and mechanical forces act, and when thus stimulated it rouses the others, which are its subordinates, causing them to work; the phenomena which result we call life. When the law of habit accustoms it to the effects of all stimuli, it ceases to act on its inferiors, the whole vital machinery stops, and death ensues. The precise moment at which the life-power departs has not been ascertained, but it is hardly possible that it remains after decay begins; at all events decomposition is the only certain test of death, and not waiting for this sign, in cases of doubt, has occasioned the burial alive of many persons.

The living seed mentioned before had its excitability roused by the warmth and moisture. Its outer husk was thrown off as a laborer throws off his coat to prepare himself for work. As it evolved, a root ran below to collect nutriment, and a stalk branched above to bear the leaves. The little bunch of leech-like vessels known as spongioles, at the termination of the root, sucked up watery matters from the soil, which vital affinity instantly digested into a compound of sugar and mucilage. By mobility the sap rose in an ascending series of vessels to the leaves, where, becoming fully purified, it attained its last stage of vivification when carried by another series of vessels through the plant to supply its wants and furnish material for its compounds. The refuse was thrown off at the roots and prevented by instinct from re-entering, as that property guards the mouths of the spongioles, to hinder them taking up any but proper matters from the soil.

The first five properties, as just defined, are common to both vegetables and animals, but the last two, in consequence of requiring a nervous system for their manifestation, belong exclusively to animals which alone possess the requisite apparatus. This constitutes the dividing line between animals and vegetables, and the importance of its application may be seen in the case of the sponge, which was formerly classed with minerals; when observation showed that it had a life-power, it was promoted to the lower ranks of plants, and finally its nervous system caused it to be placed among animals.

Sympathy is that property belonging to the nervous system which, as it were, daguerreotypes the condition of one part of the body on another part. It is the agent whose activity spreads and complicates disease, although it assists with equal energy in restoring health. By its agency a sick stomach will be accompanied with headache; and the prick of a needle which lacerates the nervous fibrils at the end of the finger will, by inducing the ill effects of the same state on other nerves, occasion lockjaw. Sensibility, or the power of sensation, is sufficiently in this place defined by its name, and together with sympathy will be considered in the account of the nervous system.

Physiology is the name given to the study of the phenomena shown by means of excitability when acting under healthy influences; it is a word derived from two Greek radicals meaning the science of nature, and in that sense was used by the ancients; but the moderns have limited its extension to the science of organized beings, thus excluding inanimate nature from its consideration.

Pathology is the study of the phenomena of life shown by excitability acting under injurious influences. Exposed to unhealthy stimuli, this property becomes depressed, and a chill pervades the system in proportion to the power of the morbid agents; if the poison is intense, it sinks, until, as in the congestive fevers of the South produced by malaria, death is the result.

As excitability has no power of itself to resist, the least exposure would be always fatal, were it not that Providence, in placing us in a world where evil as well as good is present, has given to the life-power an adjunct, which the ancients, who were well acquainted with its mode of working, called the VIS MEDICATRIX NATURÆ. Upon the existence of this wonderful power the science of medicine is based.

The dormouse furnishes a good illustration of its working: this little animal retires to its nook to sleep out the winter. In its state of torpidity its breathing is very slow, and the heat of its body is nearly that of the surrounding atmosphere. When taken carefully from its hiding-place and put in a basin which floats in a freezing mixture, in proportion as heat is absorbed it becomes colder, its respiration slower, and its heart pulsates more and more feebly; this state of things continues until it is cooled down to a point at which life would cease. At that moment an unseen power shows its workings—a secret spring seems touched, and a change takes place with extreme rapidity; the heart beats fuller and faster, warmth diffuses itself over the system, the eyes brighten, the limbs contract, and in a few minutes the little animal is as lively as in the midst of summer. Exposure to moderate cold will induce a return of torpidity, and it may be restored to its retreat, all unknowing, as it wakes in spring, of the service rendered to science.

The same conservative power that saved the dormouse operates in disease by the fever which it brings on after a chill; succeeding this fever by perspiration. It also restores heat to chilled hands and feet when riding out in cold weather, although it is well to prevent the necessity of its action by washing those parts in cold water and using friction to bring on a glow before going out. When the cold has been very severe, and the conservative power is tardy in its operation, the restoration of the frost-bitten part is best assisted by rubbing with snow or ice-water, care being taken not to expose such members near the fire, as excitability, already affected, is ill prepared for another shock, and there is consequently danger, not only of painful tingling, but also of mortification or death of the parts. So well is the necessity of cold rubbing understood, that in Canada, and other extreme northern countries, in the winter season, it is no unusual thing for a person, while walking out in the open air, to be suddenly seized and unceremoniously rubbed on the nose or ears by any stranger he may accidentally meet, to whom the peculiar blueness of the parts shows need of an instant remedy.

CHAPTER II.

THE DIGESTIVE SYSTEM.

Growth of the Human Germ—Cellular Tissue and its Composition—Atoms of Organic Compounds—Mirbel's Law not True—Stages of Digestion—Prehension—Mastication—Teeth of various Animals—Anatomy of the Human Teeth—Movements of the Jaws—Vitality of the Teeth—Artificial Teeth—Hygiene of the Teeth—Insalivation—Deglutition—Anatomy of the Esophagus—Use of the Epiglottis—Acts of Swallowing—Chymification—Anatomy of Stomach—Various Opinions of Digestion—The Gastric Juice and its Properties—Dr. Beaumont's Experiments—Animals in the Human Stomach, and the Means of their Ejection—Two Objects of Food—Repair of Waste and Fuel—Difference of Food in Warm and Cold Climates—Disregard of Hygiene—Various Kinds of Food for Animals—Nothing Wasted in Nature—Best Time for Drinking Spirituous Liquors—Hygiene of Eating—Chylification—Dyspepsia—Story of Prometheus—Dr. Johnson's Remark—Anatomy of Mesenteric Glands and Lacteals—Qualities of Chyle—The same in all Animals—The Lacteals and their Instinct—How Alcohol enters the Blood—Salt Peaches—Atrophy of Children—Passage of the Chyle to the Thoracic Duct—Closure of this Duct—Anatomy of the Intestinal Canal.

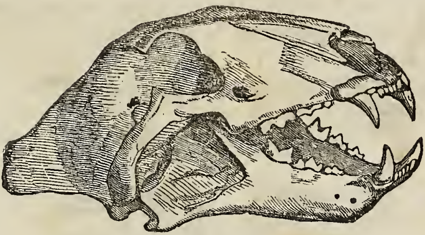
When the excitability of the human germ is first roused to action, it finds at its disposal only a little organized jelly, packed in membranous cells. Losing no time in setting the other properties at work, it forms from this material its instruments of action, as tubes, organs, and glands. A minute heart contracts and expands, sending the blood into microscopic arteries, which convey it to every part, while veins corresponding in size return with the refuse particles. Miniature bones appear, clothed with muscles, the remaining organs take their positions, and a membrane covers the whole, binding the parts together and individualizing the body. The process of development, although going on in every part of the system, is completed first at the extremities, tending from without inward, until the internal organs are perfected.

The compound atoms of living structures are inclosed in cells, the tissue to form which composes the greater portion of all animal and vegetable bodies; in fact, the lowest and simplest members of both consist merely of a series of these cells attached to each other in various positions; while the highest and most complicated differ only in the number and filling up of the same cells. When fibrin is deposited in them, they form muscles; when phosphate of lime, bones; when albumen, nervous matter; compressed and spread out, they form sheaths for muscles, bones, and nerves, lining the internal cavities and covering the body. So abundant is this tissue, that if all the organs were removed, a likeness of the human form, made up of it alone, would remain. As cotton is placed with jewels in boxes to keep them from injury, so is this cellular tissue packed around every part to support and protect, at the same time rounding the form into proportions of beauty and symmetry. Entering as it does into the minutest portions of every structure, it keeps aloof from the peculiar offices of each, and retains its own endowment, that of secreting a watery vapor from its surface; thus preventing, throughout the entire system, the least friction or adhesion of organs.

From the sixty elementary atoms the life-power selects but eighteen, and with these forms all the wonderful variety of the animal and vegetable kingdoms. CARBON, NITROGEN, OXYGEN, and HYDROGEN enter so largely into the composition of all organized substances, that the remaining fourteen seem comparatively unimportant; the first three of these are contained in the atmosphere, and the last two in water. As a general rule plants subsist only on elementary atoms, while animals require them to be previously combined by vital action. Hence Mirbel's rule drawing the distinction between the two kingdoms—"Animals live only on organic matter, vegetables on inorganic." Naturalists of the present day do not allow this as marking the boundary line; for, on the one side, the plant-parasites, as the dodder and mistletoe, live on the sap of other plants; and on the other side, instances are shown in which the lower animals, and even man, have been without other food than air and water for months and years, without losing flesh; these latter cases seem capable only of explanation by supposing their vital affinity to have compounded, as in the other kingdom, the elementary atoms. If such were the rule, instead of the exception, our sustenance would cost us but little trouble or expense.

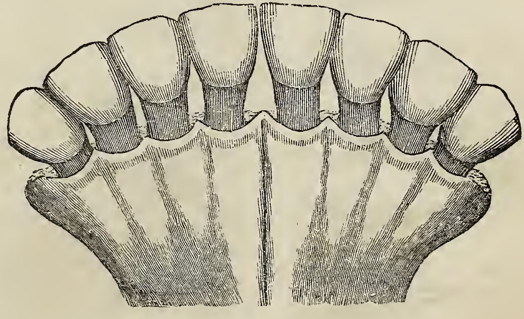
The process by which food is adapted for conversion into arterial blood is called digestion. Prehension, its first stage, is the act by which food is taken into the mouth. In most of the lower animals this is effected by the muscles of the lips, and the name has reference to it in them, being derived from the Latin, to surprise, in allusion to the seizure of the prey; in man the hands perform this act.

Mastication (from *mastico*, to chew) is performed in the flesh-eating animals, whose food requires little more than division into portions small enough to be swallowed, by the cutting teeth. The engraving shows the jaws and teeth of a purely carnivorous animal—one that feeds solely on flesh. The teeth have sharp edges, and as they are intended only for cutting, the jaws in which they are set only open and shut on the principle of a pair of scissors; the large pointed teeth serve as weapons of attack, and also to hold the prey when caught.



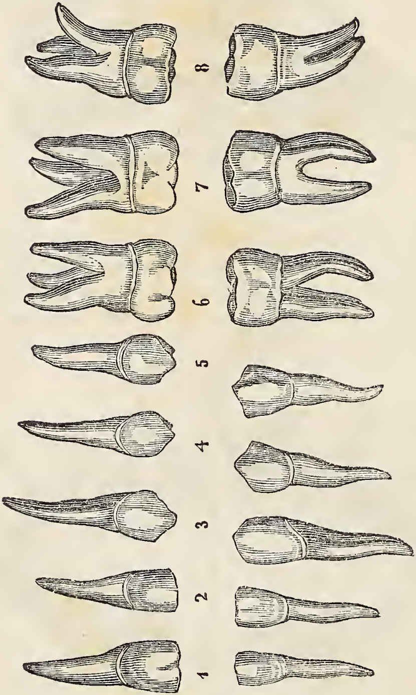
JAWS AND TEETH OF A PANTHER.

The grain-eaters, who require a separation of the husk from the more nutritious portion, effect this process by means of the grinding teeth, which are all they are supplied with. Those which ruminate have incisors in the lower jaw for cutting the grass.



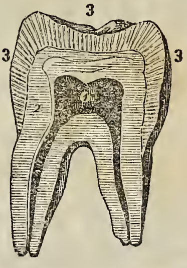
TEETH OF A COW FED ON NATURAL FOOD.

The omnivorous tribes have the requisite apparatus for both cutting and grinding. The necessity of proper mastication may be seen in the care which nature has taken to furnish us with proper instruments to effect it. It is certain that it can not be neglected with impunity, for swallowing food hastily, and with little or no chewing, is one of the principal causes of dyspepsia.



ANATOMY OF THE HUMAN TEETH.

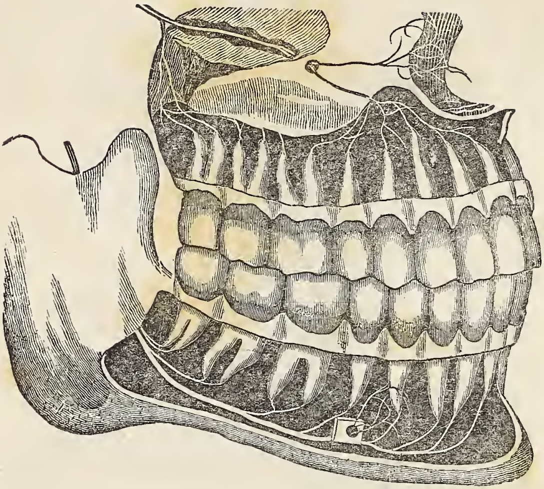
Anatomists divide the human teeth into four classes—incisors, 1, 2; cuspids, 3; bicuspids, 4, 5; molars, 6, 7, 8. The incisors, or scissor teeth, cut the food, and resemble those of the carnivorous animals; these are placed in front of the jaws, and are eight in number. The cuspids, or eye teeth, are longer than any of the others; they bound the incisors, and are four in number. The regular gradation is continued by the bicuspids, or doubly pointed (from *cuspis*, a point); these are eight in number. Lastly come the molars, or grinders, millstones in miniature; they are twelve in number, and complete the set allotted to man of thirty-two.



MAGNIFIED SECTION OF A TOOTH.

The cavity of the teeth in which the nervous pulp ramifies is shown at 1; the bony substance similar in kind to the other bones, at 2; and at 3, the enamel disposed in radii; the hole at the root of each fang shows where the nerve, artery, vein, and absorbent enter—for the blood circulates as readily through teeth as through any other part.

The jaws, of course, are capable of moving in such a manner as to allow of the teeth performing every office for which they were designed. The nerves, which are beautifully shown, will be described in their appropriate place. From the study of the human teeth in comparison with those of the lower animals, naturalists not only judge man capable of living on all classes of food, but rather incline to the opinion that he partakes more of the nature of the flesh-eaters than of the grain-eaters; which idea is still further supported by the fact that the grinders,



COMPLETE SET OF ADULT HUMAN TEETH.

or molars, are the last to be formed and the first to decay.

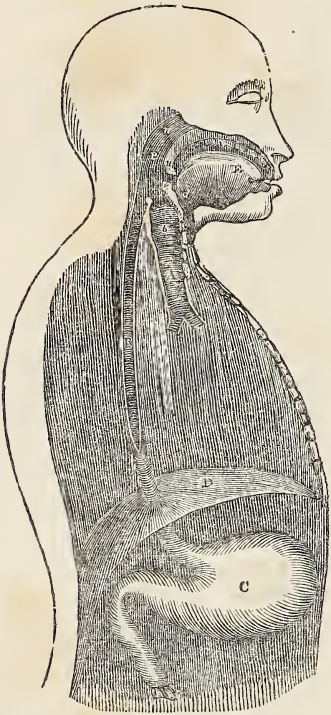
That the teeth are alive may be shown by the fact that one recently drawn and put in another socket will become fixed and grow as if it belonged to the place originally, but if out of the mouth a considerable period, so as to lose its vitality, it will not adhere or remain. As the teeth are inclosed in membranes liable to become inflamed, it is well to examine carefully, before having a tooth extracted, that it is the member causing pain, for many have been carelessly removed in this way.

So necessary is the proper division of food to the processes of digestion, that animals not provided with teeth supply the want in an artificial manner, by swallowing hard substances, the peculiar construction of the stomachs of such allowing them to do it without danger. For this purpose the ostrich takes in glass, stones, and iron nails, when it can find them, along with its proper sustenance; and it is well known that gravel is indispensable to singing birds kept in cages. The number and size of these stones are astonishing when contrasted with the capacity of the cavity that contains them. John Hunter found two hundred in the gizzard, or strong muscular stomach, of a turkey, and in that of a goose, over a thousand.

It is incumbent on all to take proper care of their teeth, and for that purpose nuts and other hard substances should not be cracked by them; biting thread and string, and using metallic toothpicks, should be avoided, as by all these means the enamel is seriously injured. A soft brush and water should be used in cleaning the teeth and gums, directly upon rising in the morning, after every meal, and just before going to bed. Quills and thin-pointed slips of wood make the best toothpicks. Very hot and very cold drinks injure the teeth, as do also tooth-powders, or washes of an acid nature, which act on the enamel.

Insalivation is the act by which saliva is mixed with the masticated food. This saliva is secreted by glands situated in the upper and under jaws, whose discharging tubes open into the mouth. It not only softens the food, but also changes its odor and flavor, its vital affinity acting upon it so as to prepare the nutriment for the next stage of the process. Haste in eating is as injurious in this stage as in the former one, and should be avoided for a two-fold reason.

Deglutition (from *deglutio*, to swallow down) consists in the passage of the food from the mouth to the stomach, through the esophagus. The motions of mastication, as soon as each portion of food is ready, places it on the upper face of the tongue, which, rising as soon as it receives



ESOPHAGUS AND AIR PASSAGES.

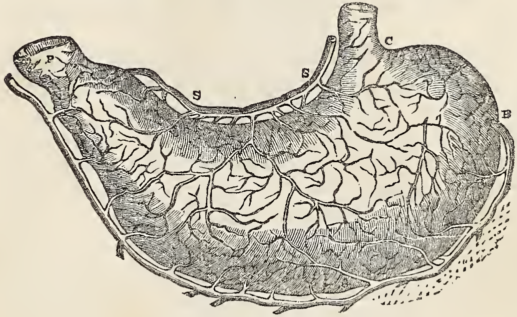
E shows the tongue; u, the palate; P and *n* the air passage between the windpipe and nose; *e*, epiglottis or cover of the glottis; A shows the tube leading to the lungs, having the larynx *b*, or instrument of the voice at its upper part; B shows the esophagus, a section of which is sliced off lengthways to discover its muscular rings; D is the diaphragm, between whose pillars the esophagus passes to reach the stomach C.

the morsel, presses itself from the tip to the base, through its whole length, against the roof of the mouth, forces the morsel backward and upward, and would throw it into the nostrils if the vail of the palate did not, by being pressed against, drive it downward and backward to the esophagus. So far the steps happen slowly and in succession, but the next stage is performed with such rapidity that Boerhaave considered it a sort of convulsion; it is done thus quickly that the windpipe may only be closed as little time as possible. While reading this description, it would be well for the student to swallow something slowly, and realize its truth in his own experience.

It was formerly thought that the epiglottis, by covering the air opening, was the only obstacle to the entrance of the food into it, but later observations show that it can, at the utmost, be but a help, as Magendie removed it entirely from an animal, which swallowed as well after the loss as before. The same muscular action that forces the morsel along completely shuts up the larynx. Speaking or laughing while swallowing forces open from within this entrance to the lungs, and by so doing retards at the same time the passage of the food, so that it is no wonder that a portion should enter the larynx from the operation of both causes; and its ejection is a happy result, even if at the cost of a severe and painful fit of coughing.

After the food has once fairly entered the esophagus, it is pushed downward by the successive contraction of the muscular rings above and the dilatation of those below, until it finally reaches the cardiac orifice, and through it enters the stomach. Magendie remarks, that nothing is more easy than deglutition, and yet every stage of it is beyond the will, as we can not make an empty motion of the process. In this manner he accounts for the difficulty some persons have in swallowing a pill, and who in consequence are forced to resort to other methods of taking medicine.

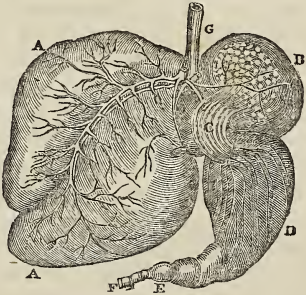
Having now entered the stomach, chymification (from *chymus*, a juice) begins. Up to this point, each kind of food retains many of its distinctive characters, but now they are nearly all lost. The gastric juice (from *gastro*, the stomach) is poured out from its glands and mixes with it. Vital affinity, acting through this secretion, separates the compound atoms and recombines them into atoms of chyme; these are homogeneous, of a grayish color, pasty consistence, and of a sweetish, slightly acid taste.



THE HUMAN STOMACH.

From its commencement in the mouth until its termination, the intestinal canal may be considered as a continuous tube, expanded in some portions and contracted in others. Where the esophagus ends it swells out into a pouch, or sack, of a roundish oblong form, largest on the left side, and gradually diminishing until it reaches the lower opening. Its superior orifice, from its nearness to the heart, is called the cardiac (from *cardia*, the heart); its inferior orifice, in consequence of its acting as a sentinel, receives the name of pyloric, from the Greek for gatekeeper. This sack is known as the stomach, a word also derived from the Greek, in allusion to its receiving what is poured into the mouth. It will contain from one to two quarts of liquid, though this capacity can be either much increased or diminished, by want on the one side or gluttony on the other. C shows the cardiac orifice; P, the pyloric;

S S and B are arteries surrounding it to furnish the necessary quantity of blood for its secretions. The stomach, like the rest of the intestinal canal, is composed of three coats, or membranes; a serous coat, or sheath, lying outermost, and enveloping it; a middle coat, which is powerfully muscular; and, lastly, a mucous coat, on whose surface lies in folds the velvety network of glands for secreting the gastric fluid. All animals possess but one true stomach, or organ, to secrete the gastric juice; the so-called stomachs of the ruminants are but pouches, whose uses we can explain in the instance of the cow.



COW'S STOMACH.

G is the esophagus, which first conducts the food into the pouch, A, where it is steeped in a fluid to prepare it for insalivation; it is then returned to the mouth to chew the cud. After being swallowed a second time, the esophagus conveys it to the pouch, B, whose mouth opens to receive it if properly chewed; if not, rejects it, to undergo the process again. After passing B, it is presented to C, to undergo the same ordeal, and if successful in every case enters the true stomach, D, to be changed into chyme, and finally carried to the pyloric orifice, E, to F, the commencement of the duodenum, there to undergo chylification. The reason of this complicated process seems to be, that vegetable food being much harder to digest than animal, requires this long elaboration to extract all its nutritive properties.

Various opinions have been advanced, in different ages, relative to the causes that convert food into chyme. One party gave the credit to putrefaction, another to fermentation, and a third to trituration by the muscular coat of the stomach. Pitcairn, who advocated the last opinion, taught that the muscular coat of this organ exerted a force of nearly nine tons. The true nature of the process was not known until the time of Cheselden, who directed attention to the necessity of a special secretion, and thus led physiologists to the discovery of the gastric fluid.

The gastric juice, when pure, is a thin, transparent fluid, without odor, and of a slightly saltish taste. It has two striking characteristics—one, that of resisting putrefaction, and the other, that of dissolving the hardest and toughest substances. Meat immersed in gastric juice taken from a crow, has been preserved pure for a period of thirty-seven days; while a portion of the same piece covered with water, began to spoil the seventh day, and was completely resolved by the thirteenth. Ivory and bone have often been digested, and a gold coin was found to be diminished in weight after passing through the stomach of a hen.

Dr. Beaumont's experiments are among the most extraordinary ever pursued in Physiology. For the purpose of studying the phenomena of digestion he took into his family a young man named St. Martin, whose stomach had been ruptured by the bursting of a gun, which had left a permanent opening, closed only by a flap of flesh, which could be raised at pleasure. Through this opening the doctor introduced food, which he could take out at various times he chose, for the purpose of observing the successive changes induced upon it by the gastric fluid. In this manner he was enabled to form a list giving the exact times required to convert different articles of diet into chyme. He found this took place more rapidly as the food was minutely divided, thus furnishing another fact to show the importance of eating slowly and carefully.

The gastric juice possesses no power over living organisms, for the less must always be inferior to the greater, and its vital affinity can not act on matter fully permeated by the life-power. It is owing to this that it does not digest the coats of the stomach while alive; but in cases of sudden death, where the vivification of that organ has been destroyed, its own fluid just secreted has changed the substance of its coats into chyme. Worms, the ova of insects and, in a few instances, some members of the reptile family, have lived and increased in size and numbers in the stomach; whenever this occurs, it shows a weakened state of its powers, as when healthy it can easily eject the intruders. Hence tonics are the proper remedies for worms in children. Excessive eating is not only injurious by wasting the secretions of digestion, but also by distending the stomach, whose muscles require to grasp the same bulk each successive time in order to work with ease. Even a single indiscretion of this kind may be attended with much injury. Darwin records an instance of a woman who ate a large quantity of food on a wager, which so increased the cavity of the stomach that she was ever after obliged to take as much again into it as she had been accustomed to before, in order to give the same satisfaction.

Food is required for two objects: one to supply the wear and tear of the system, and the other to provide fuel to maintain the animal heat. A much less quantity than we generally imagine is needed for the first purpose; the particles of the body, although continually changing their places, are used over and over again, and thus there is but little loss in the system of a healthy adult. Cold-blooded animals offer a further proof of the truth of this opinion; the generation of heat in them is so small that they vary but a few degrees from the temperature of the medium around them; it is well known that snakes inclosed in glass jars will continue in apparent health for years without any known means of sustenance, and a case is related where a gold fish was kept three years in pure water without other food than what it might possibly find in that element.

A hot-blooded animal, living in a country whose average temperature is nearly equal to that of his body, will need little more food than is absolutely necessary to supply the waste of its system by exercise, as it is not called upon to elaborate much heat; but in proportion as it is removed nearer the poles will be its demand for a greater quantity, until the amount needed for warmth will be out of all proportion to that required for wear. Thus the inhabitant of the frigid zone consumes of necessity a greater bulk of food, and that, too, of a more nutritious character, than he who lives under the burning sky of the equator.

Nature provides for the requirements of both with unerring wisdom; in warm countries the vegetables of a watery constitution predominate; as the climates become colder, they assume a more and more oily character. The lower tribes, forced to obey the indications of nature and limited to the productions of their own localities, preserve health in all situations and temperatures; but man, taking advantage of his freedom, disregards such injunctions; he carries his accustomed luxuries with him wherever he goes, and in the torrid zone will live on, or rather die on, animal food and rich pastry, whose digestion he must aid by stimulating spices and strong wines. As a matter of course, disease inevitably results, and such persistence in old habits forms one of the dangers of acclimation.

Different species of animals require different kinds of food; what is a bane to one may be food to another; there is thus a use for every thing, and in the economy of nature nothing is wasted. Barnyard fowls fatten on the seeds of many plants fatal to man, and much that he eats would be injurious to them. There are some persons so peculiarly constituted that they can not eat cheese with safety, while others partake without danger of substances that are noxious to the generality. It is a curious fact that the snake poisons swallowed have created no disturbance to the stomach, although the introduction of the least portion under the skin by a needle would have occasioned death.

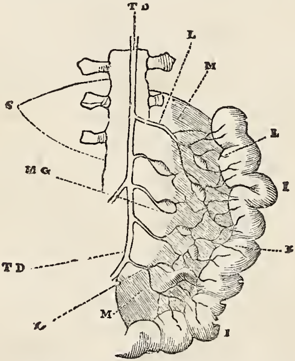
Alcoholic stimulants, besides their effect on the nervous system, excite a flow of gastric juice into the stomach which, poured into it when that organ is empty, is wasted; the least injurious time, therefore, for drinking, is either during or just after meals, when the fluid may meet with food on which to act. The English, upon this principle, drink their wines directly after dinner, and for those who will limit life in this manner their example is the safest to follow.

Appetite, while in health, is a guide for the quantity and Taste for the quality and variety of food required by the system. There is no need of rising from the table until satisfied, though care must be taken not to satiate. A writer wittily remarked that the natural language of satisfied is "enough," and of satiated "too much." Cheerful conversation while at meals promotes digestion, by removing all care and constraint from the mind, and causing the body to assume an easy, comfortable position.

The stomach, like every other organ, requires rest after working. Six hours should intervene between meals, to keep it in a healthy condition, and on no account should it be annoyed by eating in the intervals. The universal experience of civilized nations seems to sanction three meals per day, and these should be taken at the same hour for each, regularly, if we would obtain the full power and energy of the system that we need in digestion.

As soon as a certain portion of chyme is formed, the stomach shuts up the cardiac orifice, and by contracting on itself, tries to force it through the pyloric; but this substance, if not properly prepared, is refused passage, the ring of the gate-keeper tightly contracts, and it must remain for redigestion. Much trouble ensues; there is a sensation of general uneasiness; pain and heaviness are felt on the left side, and the unfortunate dyspeptic is forced to endure all the tortures of Prometheus, whose story seems intended to symbolize the effects of excess in eating and drinking. Sometimes the nausea is so great, that the same effects result as when an emetic is taken; the pyloric orifice remaining closed, the stomach, in its convulsive struggles to get rid of the offensive matter, calls to its aid the surrounding muscles, whose pressure in addition to its own contractions enables it to overcome the resistance of the cardiac orifice, and finally ejects its contents through the esophagus. Happily for the subject if one such warning suffices, and by inducing obedience to the laws of Hygiene insures escape from future tortures. Dr. Johnson remarks, that whenever we are aware of the existence of the stomach, either by painful or by pleasurable sensations, we may be certain there is something wrong.

When chyme succeeds in entering the duodenum, the combined secretions of the liver and pancreas are poured upon and mixed with it, and the result is a separation into



MESENTERIC GLANDS AND LACTEALS.

I I I I, a portion of the duodenum; L L L, the lacteals which carry the chyle to the mesenteric glands M G, and afterward convey it, when elaborated, to the thoracic duct T D. No appropriate name as yet has been given to distinguish the vessels that carry the fluid from the glands after its elaboration in them, so that both these latter and the lacteals are included under the same appellation. M is a portion of the mesentery, a membrane which supports the blood-vessels of the intestines, and the prolongation of which lines them with their serous coat, and thus binds and connects them together. The thoracic duct is seen running upward toward the neck to empty its contents into the subclavian vein; it is supported by the front surface of the spine S.

two portions, chyle and excrementitious matter, the latter to be thrown off. The chyle—so named from a Greek word meaning juice—is of a milky white color, rather heavier than distilled water, has a strong peculiar odor, and saltish taste slightly adhering to the tongue. Although the ancients were acquainted with the existence of this fluid, little was known of its real nature until the seventeenth century.

Chemists assert that the chyle of all animals is composed of the same elements, without respect to the kind of food upon which each severally subsists. It is difficult to account for the entrance into the system of many of its constituent materials, and this holds true more especially of its iron, sulphur, phosphorous, and coloring matter. In view of these facts, some physiologists contend that the life-power possesses in itself the property of generating from the substances to which it has access whatever elements it may need, and if so, the transformation probably begins at this stage.

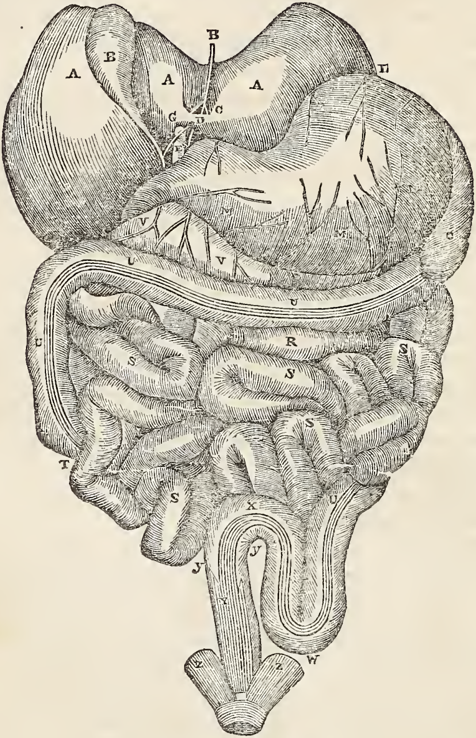
Millions of little leech-like vessels surround the duodenum, and piercing through its coats, project their mouths from the internal surface of the mucous membrane of the intestines, to select the chyle after its formation. These are called from their office *lacteals*, or milk carriers, although the fluid they convey bears no resemblance to milk except in color.

As a general rule, the lacteals take up nothing except the pure chyle, the instinct that guards their mouths doing its duty most faithfully; but instances occur in which this sentinel may be bribed. This is effected by means of the law of habit, which after a time renders instinct insensible to the presence of any agent with which it may be constantly in contact. When alcohol is drank, and thus permitted to enter the stomach, the pyloric orifice becomes familiarized to it, and allows its passage into the duodenum; acting in the same manner on the lacteals, who admit it in their tubes, and pursuing this conduct with every sentinel it meets, it finally enters the blood-channels, and courses freely through the system, saturating every portion, and imparting that peculiar graveyard odor so well known as characterizing the confirmed drunkard. By touching a burning paper to blood freshly drawn from such a person, a light blue flame will flicker over the surface a few moments, showing that the alcohol has not been compounded at all in the organized atoms, but remains in a perfectly free state. An instance is recorded where brine, accidentally thrown around the roots of a peach tree, led to the production of saline fruit—which in every particular excepting the saltish taste resembled the natural—for several years in succession. The salt in this case bribed the spongioles, in the same manner as alcohol did the lacteals.

The lacteals carry the chyle to the mesenteric glands for further elaboration; it there undergoes another change, and when it leaves them is of a slightly pinkish hue, and rather more limpid than before. The importance of this stage of the process may be shown by the observation of that disease of children called atrophy, or wasting away. The mesenteric glands seem the parts mostly affected; they swell and enlarge so considerably that they may be felt like little knots by pressure on the abdomen. It is a malady very difficult of cure, and when relief is not given, no matter how much nourishment is taken by the child, little or no sustenance is obtained by the system, as good blood can not be formed, and it gradually pines away until death relieves it of its misery.

After leaving the mesenteric glands, the fluid is carried to the thoracic duct, or chest tube, which conveys it to the subclavian vein. Cases have occurred in which, by the adhesion of the sides of this tube, it became closed, the fluids could not pass, and, as in atrophy, the system wasted away from starvation, although in the midst of plenty. Some strange instances of this affection were afforded by a family of late years, named Edson, many of whose members died successively in consequence. Dr. Edson, one of their number, was exhibited for some time, until just before his death, at Barnum's Museum, in New York city. He was called the Living Skeleton, and well deserved the name, being literally nothing more than a bony frame covered with skin; for his system in its desperate struggles to obtain nourishment had preyed upon itself, and seemingly absorbed every particle of nutriment contained in his organization.

It has already been mentioned that the intestines in man, from their commencement in the mouth until their terminating point, are one continuous tube, expanding and contracting in different portions of the extent. This tube is generally nearly six times the length of the individual when full growth is attained, and in children, of course, more in proportion: the average length is some thirty feet. Naturalists assert that its extent varies in animals with the kind of food on which they subsist; those who live on flesh, which is easily and rapidly digested, require but a short tube; the grain-eaters, on the contrary, whose food demands a long time for the extraction of its nutriment, are furnished an apparatus of immense extent. Man possesses a tube of medium length—another fact to prove his omnivorous powers. M M M shows the stomach, after leaving which the tube is divided into small and large intestines; R S S S S shows the former, which end at T, into the latter U U U; after the turn W, these terminate in the rectum X y y, whose lower extremity is clasped by the powerful muscular bands Z Z, to retain their contents. A A A is the liver; B the gall-bladder, to be described hereafter.



INTESTINAL TUBE.

CHAPTER III.

THE CIRCULATING SYSTEM.

Circulation of the Blood guessed at by the Ancients—Demonstrated by Harvey—Education, Teachings, and Success of Harvey—Proofs of the Circulation—Man has two Hearts, and their Anatomy—Dr. Mott's great Operation—Size and Shape of the Hearts—Knowledge of a Vacuum necessary to understand the Circulation—Internal Pressure of the Body—Working of the Auricle and Ventricle—Amount of Blood passing through the Hearts—Vitality of the Hearts—Spells of Rest—Case of John Hunter—Circulation through the Lungs—Shape of the Blood Atoms—Amount of Iron in the Blood—Anatomy of the Arterial System and Circulation through the Body—Aneurism—Anastomosis—Pulsation of Arteries—How to stop Bleeding from Arteries—Termination of the Arteries into Vesicles—Theory of Capillary Circulation—Anatomy of Venous System—Venous Circulation—Muscles assist Veins—Hygiene for the Veins—Interstitial Death—Absorbent System—Incessant change of Particles—Infinitesimal Circulation—Why the Absorbents can grasp Matters—Waste of the System—Vitality of the Blood—Transfusion of Blood and its fatal effects.

The circulation of the blood required many thousand years for its perfect demonstration, and although guessed at from the earliest ages, was not completely established until the time of Harvey. It is noticed in the writings of Hippocrates; Aristotle gives, in his works, abundant evidence of his belief of it; Servetus openly taught it about the middle of the sixteenth century; and in a book published at Pisa, in 1569, written by Andrew Cesalpinus, there is a passage which indicates an almost complete knowledge of the subject. All this shows that nature, in every age, has abundantly rewarded those who studied her phenomena earnestly and faithfully.

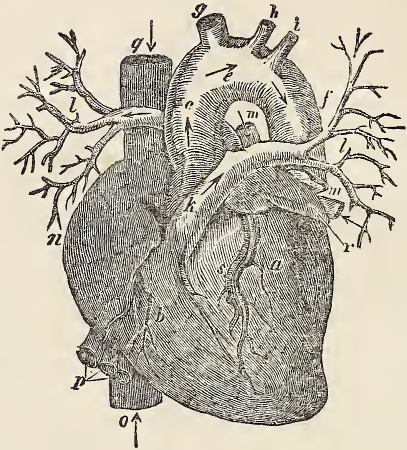
Harvey is said to have had his attention particularly directed to this subject by the discovery of valves in the veins which would effectually prevent the blood in them proceeding in any other direction than toward the heart—a fact sufficient of itself to show the falsity of the prevalent opinion of his time, that the blood flowed through the veins to the circumference of the body in the daytime, and flowed back again at night by the same channel. It is probable that he gained some hints in regard to the matter in Italy, as he was a graduate of Padua, which then contained the most celebrated medical school in the world.

Harvey did not publish his views until he was able, by repeated experiments, to confirm and illustrate them in every possible way the subject will admit. Strange to tell, their announcement at first brought him into great disrepute; he lost much of his practice, and no physician over forty years old would receive them in Europe. But he lived long enough to find them taught in every medical college, and to see his bust in marble, with a suitable inscription, placed in the great hall of the institution of which he was one of the lecturers, and to be afterward chosen president of his college, although he declined the honor, on account of age and infirmities. He finally died in great honor and affluence.

The following are among some of the facts adduced to prove his theory of the circulation. By opening the chest of a frog its heart may be seen to contract and dilate, and after a short interval of rest to repeat the same action, showing evidently that it is receiving and pumping out blood. Being a cold-blooded animal, and consequently one whose circulation is slow and languid, the web of its foot placed under a microscope will show the gradual passage of the blood from the arteries into the veins. All arteries are furnished with valves which will allow the blood to pass only *from* the heart, while the valves of the veins only permit it to pass *toward* it—the valves in each case closing when the blood would take a contrary direction, and perfectly preventing its escape backward. In bleeding from the arm, surgeons are careful to compress the veins with the bandage without impeding the circulation in the arteries lying below. If the bandage is too tight the veins can not fill; but if properly adjusted, the arteries carry blood to the extremities of the arm, and the refuse returned by the veins discharges freely through the orifice made by the lancet. From these facts the reason is plainly seen why surgeons, after amputating a limb, tie only the arteries, the valves in the veins above the severed portions preventing the blood in them flowing backward and thus escaping from the wound.

Man, in common with the higher animals, is provided with two hearts—one to send the blood through the lungs, and the other to convey it through the system; in other words, each heart makes the first of a series of movements by which these objects are effected. For the sake of convenience both hearts are placed together, so that they take up little more room than one alone would do.

The heart is commonly described as a muscle of immense power, divided into four cells, or cavities, each of which is furnished with valves to prevent the blood flowing backward when it has once entered them. The upper cavities are named auricles, from their resemblance to a dog's ears; the lower ones, in consequence of swelling out, are named ventricles, or bellies. The vena cava ascendens is shown at *o;* the vena cava descendens at *q; p* represents veins emptying into the cava; the contents of all the venous trunks are intended to be discharged into the right auricle *n*, which becoming filled sends the blood into the right ventricle *b*, whose contractions throw it into the pulmonary artery *k*, which, by its subdivisions *l l l*, conveys it to the lungs. After passing through the air cells it is carried by four pulmonary veins, two of which are represented by *m m*, to the left auricle *r;* this sends it into the left ventricle *a*, from whence it is discharged into the



HUMAN HEARTS.

aorta *c e;* the first artery given off by the aorta is the coronary *s*, for the supply of the heart itself; *q* is the innominata which divides into two trunks, the right carotid for the right side of the head, and the subclavian for the right arm. The innominata was tied for the first time by the celebrated Dr. Mott, in 1818, and was the greatest operation in surgery of his day.

Both hearts together are about the size, and something of the form, of the closed hand of the individual to whom they belong. Each cavity holds two ounces, or half a gill. The blood contained in the subclavian vein is emptied into the vena cava in readiness to be sent to the lungs for further purification by the right heart, whose auricle suddenly expands and forms a vacuum, at the same time opening its valves to allow the blood to rush in and fill up the cavity.

Dr. Good remarks that it required a period of three thousand years to render the doctrine of a vacuum probable, and of five thousand six hundred to establish it upon a solid foundation; he gives the credit of its probability to Epicurus, and of its certainty to Sir Isaac Newton. How much the discoveries in one science often aid the progress of another may be seen in this instance, for without understanding the nature of a vacuum it is impossible to comprehend the theory of the circulation, for each cavity in the hearts acts alternately as a suction and as a forcing pump. When the auricle contracts it fills up the space so completely as to eject even the last drop of blood, so that its subsequent expansion produces a vacuum, and this is the most active cause of the blood from the venous trunks pouring into it. But a vacuum alone is of no avail, unless there is pressure to fill up its space, and it is necessary to inquire as to the existence of this pressure.

When the palm of the hand is placed on an open cylinder over the air pump, and the air exhausted under it, it will be found that just in proportion to the rarefaction the hand swells until the distension becomes too painful to endure. Those who go up in balloons experience much inconvenience from this source, and travelers have ascended mountains to such a height that the weight of the atmosphere was not sufficient to resist the internal pressure, and the blood has burst so profusely from the surface of their bodies that they have been forced to return before reaching the summit. Such instances show that man is not conscious of the many bonds that confine him to the planet on which he is placed until he tries to loose himself from them. These facts demonstrate that every portion of the system has a mean pressure inside, just equal to the atmospheric pressure outside, some fifteen pounds to the square inch—a force fully sufficient to force the blood into the auricle when the latter expands to form a vacuum.

When the auricle becomes filled with blood, its valves close, and it contracts at the same instant that the ventricle below expands, producing in its turn a vacuum, and throwing open its upward valves to receive the blood which, by a double necessity, rushes in and fills its cavity. The valves communicating with the auricle then close, those of the pulmonary artery open to receive the blood which is forced into that vessel by the contraction of the ventricle.

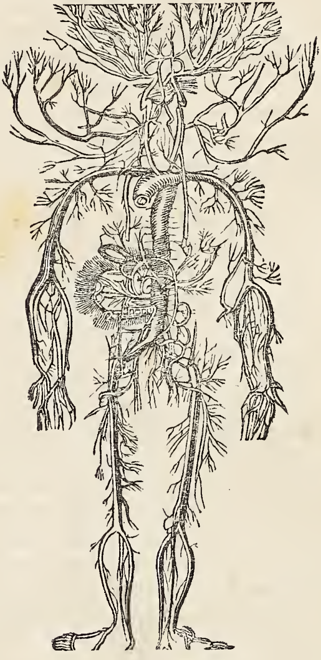
As each cavity of the heart holds two ounces, and as it contracts every time the pulse beats, which, in the average of adults, is some seventy times a minute, the quantity that passes through may be easily estimated: thirty-five gills per minute make over sixty-five gallons in sixty minutes, and both hearts working at the same time, more than TWO HOGSHEADS per hour traverses them.

It is the common opinion that the irritation of the blood is the sole cause of the motions of the hearts, but this will not account for the expansion of the cavities when no blood is in them. That it possesses, in itself, an inherent power of action, may be shown from the fact, that when taken out of the body of a bullock, and pricked, the first motion generally produced is that of expansion; of course this can only be done a very short time after apparent death. A case is related where the heart of a sturgeon was separated from the surrounding parts, cleaned, and hung up to dry; so great was the irritation excited by these operations, that it continued working, contracting, and expanding, until its rustling, after it became somewhat dry, could be heard over every part of the house.

In common with the whole organism, the heart requires rest after working; this it takes as it goes along, stopping only for short intervals, for an obvious reason, as a long cessation of its action, except in extraordinary cases, would be fatal. One such case is recorded by Home, who relates that his brother-in-law, John Hunter, in 1769, being then forty-one years of age, and in supposed good health, was suddenly attacked with a pain in the stomach, which was soon followed by an entire suspension of the actions of the heart, and consequently of the lungs also; by the power of the will he occasionally inflated the latter, but over the heart had no control whatever; at the end of forty-five minutes it began beating of its own accord, and all went on as well as before; during all this time, sensation, thinking, acting, and willing were as strong and perfect as ever. If the time that elapses between the contractions of the heart is divided into four parts, three of these will represent the period of its activity, and one of its repose; so that it is inactive one quarter of the time, or six hours out of the twenty-four.

After the blood enters the pulmonary artery, it is carried, by means of the contraction of that tube, to the lungs. At this stage it is of a deep purple color, and unfit for nourishing the system. Arrived at the lungs, a surprising change takes place; becoming purified and recombined in its passage through the air cells, its color is now of a bright scarlet hue, and it is fully prepared to supply the waste of the body and furnish material for its secretions. An atom of it contains eighteen elements, according to some writers; this, when viewed through a microscope, is said to resemble in shape a spangle, with the dot of iron in the center, occasioning the humorous remark, that the wheels of life ran on iron axles. The amount of blood in the body is estimated at one sixth the entire weight, or twenty-five pounds out of one hundred and fifty. Of this, nearly three ounces are supposed to be iron, enough, were the metal extracted and prepared, to make a chain several yards in length.

Four veins carry the blood from the lungs to the left auricle, which, by the same process as that mentioned for the right auricle, expands to receive it, contracts and throws it into the left ventricle, from whence it is sent to the aorta to traverse the system.



ARTERIAL SYSTEM.

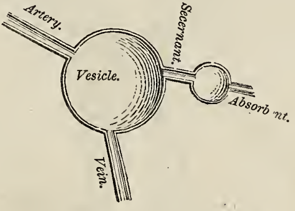
The engraving shows the aorta, after leaving the left ventricle, distributing branches through the system to supply every part: it terminates in two trunks at the inferior portion of the spine, which go to the lower extremities. As tubes may be seen running to each of the organs, etc., it is unnecessary to particularize their names. The semicircular radiating series about the middle of the aorta, which go to nourish the intestines, are beautifully shown. Anatomists count but two arteries in the system, the pulmonary and the aorta, considering the rest as mere branches. Each artery has three coats—one externally, of cellular tissue; the middle one of a yellowish hue, much thicker than the others, and so highly elastic as to be often described as muscular; the inner one is of a serous texture, and very smooth and polished, to allow of the rapid passage of the blood. It sometimes happens that the elastic coat loses its contractile power, and yields to the pressure of the blood with each successive pulsation, until at last a tumor is formed, which, as it grows to any considerable size, so loses its elastic power that it ceases to beat. The least injury done to such a tumor, by opening it, will cause a torrent of blood to rush forth, and produce almost instant death. The conservative power sometimes clots, or coagulates, the blood in them, and thus prevents all danger. Anatomists often find arteries that have burst and healed themselves; and done all this, too, so quietly that the danger was unknown during life to the individual concerned, and only discovered by an examination of his bodily frame after he had left it behind him. What human engineer could so contrive a series of pipes, not alone to work with such unequaled power and precision, but also to repair for themselves any accidents that might happen, and heal their own ruptures? Astronomy, it has been said, displays the wonders of Providence on the vast scale, and anatomy on the minute; and it is no wonder that Galen believed in a Deity after he had dissected.

When surgeons find an aneurism (the name of the tumor just described) enlarging and beyond the power of nature to heal, they assist in the formation of a coagulum, or clot, to fill the tumor, by placing a tight ligature on the vessel between the heart and the swelling; this causes the sides of the tube to unite, and effectually closes the passage. So extensively do the arteries anastomose, or communicate with each other, that this closure of the main trunk, or channel, produces but little of the trouble that might be expected, for the circulation is carried on by the smaller vessels, which soon enlarge to meet the demand.

The surgeon, before bleeding from the arm, feels carefully around the vein he is about to cut, to ascertain if he can discover any beating; if so, he chooses another vessel, as such beating denotes the presence of an artery that he would not risk wounding by the lancet. The physician compresses the radial artery against the bone of the same name when he would feel the pulse. As all the arteries sympathize strongly with each other, the state of the heart and entire circulatory system can be told by the examination of any main trunk.

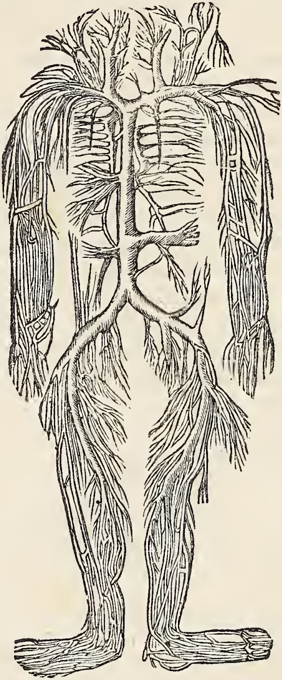
The arteries do not beat at the same instant as the heart; in proportion as they extend to the extremities the greater is the interval that intervenes, although the longest must be but an exceeding short space of time; the cause of the delay is the period taken by successive portions of blood to reach them. As a general rule, they all lie very deep-seated, and protected from injury by the softer parts; where they are forced to appear externally, as in the temple, wounds of such parts are very dangerous, from the excessive flow of blood caused by rupturing the coats of the blood-vessels; they may be known by the successive jets of bright crimson fluid. To stop the flow of blood it is only necessary to find the main trunk that leads to the place between it and the heart, which may be done by feeling around, at a little distance, until the beating is perceived, and compressing it by the fingers, or better still, the end of a key, or head of a pencil; if successful in stopping its pulsation no great danger need be feared until the surgeon arrives. If the injury is on any of the extremities, a very tight bandage, with the knot as nearly as possible over the main artery leading to the part, of course between it and the heart, will answer. Many lives have been saved in this way.

The aorta, as before mentioned, and as may be seen in the engraving, sends out branches in all directions; these continually subdivide in their ramifications, becoming smaller, and more and more minute, until immeasurably less in size than a hair they terminate in vesicles of infinitesimal capacity. Each of these little vesicles has three openings—one for the artery to enter, one for a vein, and one for a secernent. An atom of arterial blood, composed of eighteen elements, is deposited; the secernent selects what it requires, carries off the atoms chosen, instantly recombines them, and conveys the newly-formed compound to its appropriate place; if in a bone, it prepares phosphate of lime; if in a muscle, fibrin; and if in the brain, albumen; the residue is sucked up by the leech-like extremity of the vein, and conveyed away to make room for more deposits. These vesicles are known as the capillaries.



MAGNIFIED VESICLE, WITH VESSELS.

The veins, like the arteries, have three coats or tunics, with this difference, that the middle coat is much thinner, and not elastic enough to induce pulsation when compressed, consequently much weaker, and the venous circulation is very languid; it is much assisted by the pressure of the muscles surrounding it, whose contractions force the blood onward; for the latter reason their communicating branches are much more numerous than in the arteries; and the slightest urging sends it toward the



VENOUS SYSTEM.

heart, if not in the channel where compression is made, into another equally efficient, and always ready, for not a particle of it can go backward. We must not suppose, in consequence of its needing this help, that therefore there is any defect in the venous system, on the contrary, it works equally well with the arterial, and we are called upon to admire the wonderful contrivance by which the proper proportion of blood is kept at the circumference, and prevented from being heaped up in the center, where its accumulation would retard the action of the hearts.

The little tubes that leave the vesicles, continually unite with others similar to themselves, until they form trunks much larger than the arteries in diameter. The two main trunks are called, by anatomists, vena cava ascendens and vena cava descendens. A branch of the large vein, that receives the refuse blood from the organs of the abdomen, enters the liver, and ramifies through its substance to furnish material for secreting bile.

As muscular contractions materially help the veins in carrying their blood, a good degree of exercise is absolutely necessary in order to insure its proper circulation. The danger of externally compressing them may be seen in the effects produced by the bandage when blood-letting is performed. On this account, if on no other, the clothing should be loose and easy, fitting the form, and worn so that no pressure is made upon any part of the body. Many of our fashionable belles, under the unfortunate delusion that they are rendering themselves more beautiful by tight lacing and tight dressing, so compress the venous trunks that they appear in public with swelled feet and ankles, the veins of the hands turgid and blue, and their countenances flushed, all which symptoms, if they continue, are the sure forerunners of dropsy.

Matter is unable to associate but a short time with the subtile essence of life; no sooner does this fickle principle vivify it than its embraces destroy, interstitial death ensues, and an absorbent always on the watch is enabled to grasp and carry off the particle. These absorbents penetrate the system, and, uniting in trunks, finally carry their dead atoms for burial, in the thoracic duct, to be emptied in the subclavian vein, which is thus replenished from three different sources—its own veins, the lacteals, and, lastly, the absorbents.

"There is arising," says Dr. Johnson, "from every part of the body a countless number of little vessels actually engaged in eating it up. They may be compared to a swarming host of long, delicate, and slender leeches, attached by their innumerable mouths to every point of the fabric, and having their bodies gradually and progressively united together until they all terminate in one tail, which tail perforates the sides of one of the veins at the bottom of the neck; so that whatever is taken in by the mouths is all emptied by the other extremity into that vein, where it becomes mixed with the blood."

Every particle of matter in the system is thus undergoing incessant change—thoroughly permeated one second by the life-power, and the next rejected, to undergo a long and complicated preparation for another embrace, to be followed by the same results. Truly, in life we are in the midst of death. The forced state is kept up to the utmost by intense stimulation. A few moments suffices to transform the whole body, although as each atom that is deposited is identical in constitution with its predecessor, the system in that respect is not altered. "To be another yet the same," was the wonder-struck declaration of an old philosopher, who had studied just enough to perceive the transmutation, without being able to explain the process.

When it is considered that the capillary vesicles must themselves be supported by a smaller system of vessels, terminating in other vesicles, and these again by a still more minute system, and so on to an almost infinite series, the largest set of which is beyond the sight of the most powerful microscope, we can no longer wonder that a drop of water may contain millions of inhabitants, each of which is endowed with a curious and intricate system, as complicated in many respects as our own, with its heart, nutritive organs, arteries, veins, and absorbents. If the undevout astronomer is mad, what, with such facts before him, must the undevout physiologist be?

Whenever from any cause a portion of the system has lost its vitality, the absorbents seize upon the particles of which it was composed and carry them off; more especially is this true of morbid growths, whose vivification never rises to a high degree. Advantage has been taken of this principle by Dr. Mott in curing tumors. He tied the arteries leading to them, thus causing them to suffer to such a degree that they were unable to resist the action of the absorbents, which in consequence rapidly removed them. Pressure on the tumors externally has had the same effect, in diminishing the quantity of blood sent to them. Instances are related where scurvy has so lowered the tone of the system that old ulcers, which had been filled with new flesh for years, have broken out afresh, and fractured bones, which had been united and healed a long time, separated anew. When the system is suffering from want of sufficient food, the effect is such upon the deposits of nutriment stowed away in the fatty tissues and in the marrow of the bones, that being new formations, they lose the power of resisting the action of the absorbents, which seize and carry them into the thoracic duct. In this way abstinence makes the fat man lean, and the lean man waste to a skeleton.

To John Hunter is not only due the credit of greatly extending our knowledge of the absorbent system, but also of demonstrating the vitality of the blood. He showed that this fluid, like solid muscular fiber, contracts upon the application of stimulus; that it is capable of preserving its own temperature in all variations of the atmosphere; and that it shares with the solid parts in the effects of a stroke of lightning. He favored the doctrine common in his day, of regarding the blood itself as the source of life. The Jews believed this opinion, and cited in proof of it the text declaring that "The life of all flesh is the blood thereof." The earlier nations of remote antiquity held the same view. Homer evidently alludes to it when he writes of "purple death," and Virgil when he mentions "purple life." All the facts brought forward, however, merely prove that the blood is alive, and still leave us to discover what gives it vitality. But of such prevalence was this opinion even in modern times, that it led to the doctrine of a revival of life, or perpetual youth, to be obtained by those who filled their veins with the blood of younger persons. In France it reached such a height as to be practiced by the highest classes of society. Many deaths ensued; a prince of the blood royal fell a victim, when it was forbidden by government, and gradually became obsolete.

CHAPTER IV.

THE GLANDULAR SYSTEM.

What is a Gland ?—Glandular Products of Vegetables—Glandular Products of Animals—Mysterious Nature of Vital Combination—Lachrymal and Salivary Glands—Teeth Glands—Anatomy of Infant Teeth —Development of the first and second Sets of Teeth—Anatomy of the Lungs—The Vocal Apparatus—Anatomy of the Trachea and Bronchial Tubes—Composition of Atmospheric Air—Davy's Experiment—Allen and Pepys' Experiment—Proof of Expiration of Carbonic Acid—Identity in Effect in holding the Breath and breathing the Gas—Various Matters excreted by the Lungs—Quantity of Air breathed per Hour—Respiration deteriorates the Atmosphere—Means of its Purification—Fable of the Persian Poet—Ill Effects of badly ventilated Rooms—The Black Hole at Calcutta—Erroneous Opinions—Anatomy of the Liver—Ancient Divination—Human Sacrifices—Qualities of Bile—Anatomy of the Internal Organs of the Body—The Pancreas and its Uses—The Spleen and its supposed Office—The Kidneys and their Uses—The Mucus Glands—Properties of Mucus—The Hair Glands, their Uses, and Hygiene—The Oil Glands, their Uses, and Hygiene—Care and Contrivance of Nature for all Organized Beings.

A GLAND is a collection of little cells, more or less in number, which are under a special agent of the life-power whose office it is to secrete from the blood a particular compound. The little vesicles of the capillaries mentioned as before existing at the termination of the arteries, and having three openings to admit the arterial, venous, and secernent tubes, differ only from the glands by the secernent tubes of the latter uniting into a common trunk for the purpose of conveying the secretion to the place where it may be used for the purposes of the living economy.

GLAND.

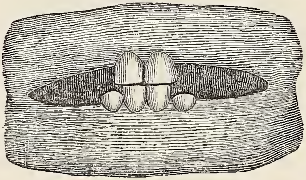
The enumeration of all the glandular products would not only take up several volumes, but also be without any practical value to the student, for whom it is only necessary to name the most important. It is to the glands of vegetables that we are indebted for all the essential oils and medicinal principles they afford. These little bodies, endowed with power superior to that of the greatest chemist, form, mostly from the elements of air and water, the perfumes of rose, lemon, lavender, and cinnamon; medicines, as *quinine* in Peruvian bark, and *salicine* in the willow, and even deadly poisons, as those of the upas and prussic acid. We thus see that the vegetable kingdom is the great provider for the animal, not only of food, but even of luxuries and medicines, for in small doses the poisons are given as the last.

The animal kingdom not only employs the products of plants, but in most cases expends its own secretions in the economy that compounded them. Albumen, one of these, can be examined in its pure state in the white of an egg; it has neither taste, color, nor smell, and hardens by heat, acids, and alcohol. Fibrin is the compound deposited in the cells to form muscles; it is of a yellowish white color, and hardens merely by exposure to the air. Osmazome is of a yellowish brown color, and principally noted for giving to soup its aromatic flavor. Gelatin, or glue as it is called, when dry, dissolves in boiling water to form a jelly. It enters so largely into the composition of bone, that quantities of the latter are ground and boiled for the poor, in France and England, affording out of what would otherwise be worthless a cheap and nutritious article of sustenance. Other compounds will be noticed in connection with their glands.

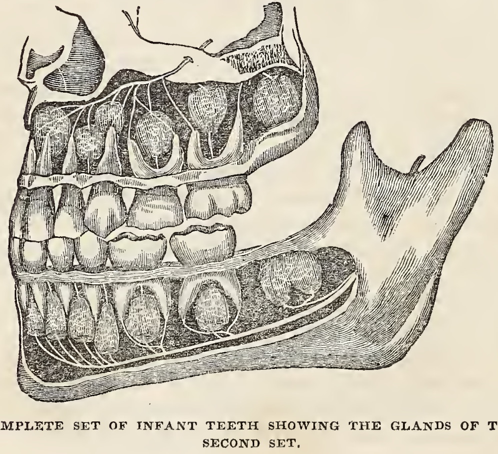
Few things have puzzled chemists more than the results of the analyses of secretions. From carbon, oxygen, hydrogen, and nitrogen, they discover the production of an immense number of compounds whose variations, to use their own words, are due almost entirely "to the number and grouping of identical elements; thus *urea* has the same atoms exactly and in the same proportion as *cyanate of ammonia;* and there are other substances differing in nature and appearance, the one a gas, the other a liquid, and the third a solid, in all three of which the atoms are the same in kind and number. Such instances accumulate until they are unwillingly forced to concede that there is a power at work whose methods of grouping and combining are diverse in every respect from those of the chemical and mechanical forces.

The lachrymal glands, situated in the orbits of the eyes, secrete tears; the salivary glands, situated in the upper and under jaws, secrete saliva; but as in most cases the names of the glands are derived from their offices, only the more important structures will be mentioned, and these will be reviewed in order, going downward according to their position, beginning with a description of the growth and formation of the first and second sets of teeth.

The teeth glands make their first appearance in the form of small pulpy substances inclosed in a membrane, supporting a dense network of blood-vessels, and lying in little pits in the future sockets, which latter soon develop and are ready to hold the teeth. The pulps gradually harden; bony matter is secreted around them; their upward pressure causes the absorption of the gum above, and at eight months the entire process is far enough advanced to allow the protrusion of the two lower front teeth; the pressure of these on the opposite gum assists the upper two in their progress, which accordingly soon after make their appearance; these are succeeded by one on each side of the



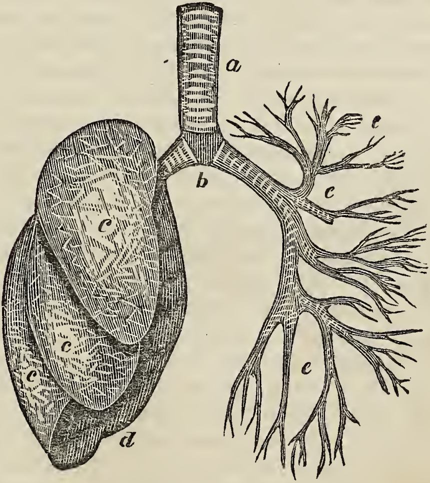
FIRST INFANT TEETH.



COMPLETE SET OF INFANT TEETH SHOWING THE GLANDS OF THE SECOND SET.

lower two; the front grinders then rise from the gums; next the eye teeth, and lastly the back grinders. Generally at the age of two years the infant has its complete set of twenty which are in readiness for working; in each jaw are four cutting teeth, or incisors, two eye teeth, or cuspids, and four double teeth, or grinders.

About the age of seven years, the jaws are sufficiently enlarged to allow the development of the second set; the glands of these latter lie directly under the first as far as they extend, so that as the permanent set become perfected, their pressure causes the absorption of the attachments of the ones above to their sockets, which latter thus set free are then shed, or thrown off.



LUNGS AND BRONCHIAL TUBES.

THE LUNGS are composed of an immense mass of little air cells, the extent of whose internal surface is supposed to be equal in extent to twenty thousand square inches. So great is their levity, that in a healthy state they will not sink in water; hence the common name of *lights* which is given to them. The mass is divided into five large lobes, three being in the right side of the chest and two in the left, the place of the third in the latter being filled up by the hearts. The bronchial tubes continually ramify and subdivide, until their extremities become sufficiently attenuated to enter the air cells, by means of which the blood receives its last degree of vivification.

By turning back to the engraving of the esophagus, the relative position of that organ to the windpipe and mouth may be seen. The larynx, which is there shown, resembles in shape and very much in office the upper part of a flageolet. It is composed of five pieces of cartilage, of various forms, so placed together that the whole resemble a hollow cone reversed, with its base upward, in which is a three-sided opening at the root of the tongue, where the air enters. Inside the cartilages are the vocal cords, about the sixth of an inch in width, whose vibrations take the principal part in the modulations of the voice; for so little aid does the apparatus in the larynx derive from other parts in the necessary production of sound, that after the tongue has been removed, persons thus injured have been enabled to converse with fluency. Practice in speaking by means of the larynx alone, and keeping the tongue still, makes the ventriloquist.

The trachea, or windpipe *a*, begins at the termination of the larynx, and extends downward, dividing at *b* into the bronchial tubes, which divide continually into smaller branches *e e e*, until they become minute enough to enter the air cells. The upper portion of the trachea is mostly cartilaginous, or gristly, but as it lessens in diameter it becomes more membranous, and the finer tubes, until we lose sight of them on account of their minuteness, are wholly of the latter character. The mass of air cells are shown at *c c c; d* represents the form of the lower part of the lobes. To allow for the expansion and contraction of the lungs, the bronchial tubes and their branches overlap each other as they join, like the tubes of a spyglass, and being furnished with bands of muscular fibers that run lengthwise throughout the whole extent, and also encircle them, they are enabled to contract and dilate as their necessities require. The cartilaginous nature of the rings of which the trachea is composed, by being incapable of closing, allows at all times free passage to the air.

Atmospheric air is composed of twenty-one volumes of oxygen gas to seventy-nine of nitrogen; and as this mixture was supposed to have free access to the air cells, it became a matter of much interest to discover what portions were used in combining with the blood. Davy made nineteen respirations in an oil silk bag, containing one hundred and sixty cubic inches of atmospheric air. On analyzing the contents of the bag, he found that eighteen cubic inches of the oxygen had been consumed, with four cubic inches of nitrogen, and their place supplied by fifteen cubic inches of carbonic acid gas. Messrs. Allen and Pepys, in 1808, repeated his experiments, and confirmed his statements, except with regard to the nitrogen, which, they affirmed, was not diminished, being returned in every expiration in the precise proportion in which it was received.

It is probable that Messrs. Allen and Pepys were correct, and that the air cells admit only the oxygen of the atmosphere, excluding the nitrogen, and not it alone, but all offensive substances, as the various kinds of dust and tobacco smoke. Instinct may do this, by closing the opening where the termination of the bronchial tube enters, whenever foreign matters present themselves, in the same manner that the pylorus contracts when improperly prepared chyme attempts to pass its gates.

That carbonic acid is thrown off by the lungs may be proved by expiring through a tube into lime water; white flakes of chalk soon make their appearance on its surface; and chalk being composed of carbonic acid and lime, shows by its formation the addition of the former substance to the latter. The importance of throwing off this gas from the system is well known. No animal can inhale it and live. Holding the breath, and thus inducing its retention in the lungs, will, of course, be followed by the same effects as breathing it from an external source. Cases are related where persons have become so violently enraged that respiration has ceased entirely, and death ensued, and this retention hastened the fatal result.

Not only do the lungs throw off carbonic acid, but various other matters, as watery vapor and the odors of different substances that have been eaten, such as onions and garlic. The watery vapor may be noticed in the clouds formed by our breathing on frosty mornings. The excretion of offensive odors by the lungs is the cause of the foul breath of many persons, who use the tooth-brush and scent the mouth with perfumes in vain, until a proper course of diet and exercise, and, it may be, of medicine, removes the cause of trouble. Such odors separate from the substances producing them in the stomach, and, bribing the instinct of the sentinels that oppose their passage, enter the circulation, but can not proceed farther than the air cells of the lungs, where they are finally ejected.

Assuming nineteen inspirations per minute, and thirty-two cubic inches taken in at each inspiration, it will amount to six hundred and eight cubic inches of air per minute, or one hundred and fifty-seven gallons per hour. This calculation shows that it requires the presence of some two and a half hogsheads of air to pass through the lungs, while little over a hogshead of blood is coursing them.

Were we placed in a perfectly close room, the carbonic acid we throw off on the one hand, and the oxygen we consume on the other, would soon poison the air, so that its respiration would be fatal. It has been calculated that air containing three and one half per cent of carbonic acid gas is unfit for breathing. Since their creation, all animals have thus exhausted the atmosphere of oxygen, and charged it with this gas. Immense as is its volume, forty-five miles in height around the earth, it would rapidly deteriorate were there not some method by which it was constantly purified. This is done by the vegetable kingdom, whose respiration is the exact opposite of ours—they throwing out oxygen, and taking carbonic acid. Were they swept away from the earth, our leases of living on it would be short indeed.

The Persian poet, Saadi, wrote a beautiful fable of the rose and the nightingale, which proves that he understood as a philosopher the harmony which he sung as a poet. The nightingale is imprisoned in a cage of glass, with a rose bush in full bloom. Each gives life to the other. Deprived of fresh air, the bird would soon cease to swell his little throat with harmony. The rose greedily absorbs the air which has been rejected by its loved philomel, and blushes to brighter tints; respires, transforms, and returns it purified, to be again inhaled by the bird, which again decomposes it, to be neutralized anew by the rose. When the bird at length expires, singing its dirge of gratitude, the rose bush withers and dies.

It is not, as has been generally supposed, owing to the absence of oxygen that the ill effects are due that are experienced by crowded assemblies in badly ventilated halls. Such air has been analyzed, and found to contain as much oxygen as that of a forest where innumerable leaves are perpetually elaborating it. There is probably more carbonic acid present than usual, but the principal cause of trouble arises from the pent-up human exhalations, which no transfusion of gases can remove. Nothing but a good draft can purify such air; and these facts should make us doubly guarded to see that our apartments have such, without exception. The openings for this purpose should be in or very near the ceiling.

One hundred and forty-six persons were shut up in a room, called the Black Hole of Calcutta, only eighteen feet in dimensions each way; and by morning but twenty-three remained alive, and several of these died afterward of putrid fever. We see from this that the effects did not cease upon removal, and that the animal poison thus generated was intense enough, in the majority of the cases, to depress excitability at once to the death-point; and in most of those who escaped, the vis medicatrix could not succeed in rousing the system sufficiently to obviate the ill effects of the morbid agent.

Saadi's bird died at length in its confined chamber, although the carbonic acid was removed, and an equal volume of oxygen supplied in its place. How much more likely are they, then, to suffer who live sedentary lives, shutting themselves up in close rooms, and exposed not only to the effects of their own exhalations, but to those produced by impure air. Health can not be preserved except by exercise out of doors, where the breezes of heaven are allowed to brace the system and carry off its impurities.

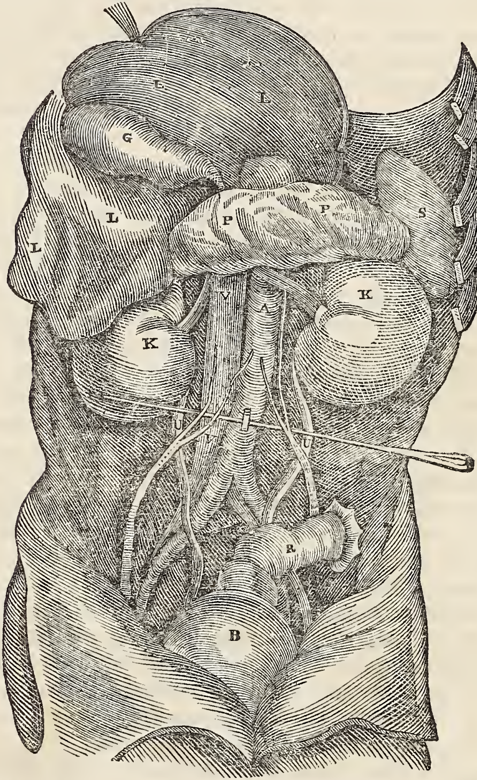
It is generally supposed that wherever combustion will take place it is safe to breathe, and, accordingly, candles are let down into wells, and if they continue to burn, it is judged harmless to descend; but this opinion is erroneous, and much injury has been done by acting according to it, as a per centage of carbonic acid, being injurious to the system, will yet permit combustion.

The Liver forms the largest collection of glandular cells in the body. It is of a deep red color, and weighs in the human system, at the average, about four pounds. It is situated on the right side, directly under the diaphragm, and is divided into numerous lobes.

Much of the anatomical knowledge possessed in early ages was derived from the practice of sacrificing to the gods, to avert their anger and propitiate their favor. To be acceptable, the offering must be the most perfect of its kind. The external form of the victim, as well as its internal organs, were carefully scrutinized, and if spot or blemish was found, unhesitatingly rejected. The structure, form, and position of the deep-seated parts were particularly subject to this inspection. According to heathen belief, it was by marks on such portions that the gods were wont to manifest resentment or good-will; and not only this, but to point out to them the course of future events.

The liver was the great source of information of this kind, and the minute examination bestowed upon it is evident from the number of parts into which it was divided. Anatomists, by leaving out of mind that the necessity for such scrutiny has ceased, have retained too many of the old divisions, with their often absurd names; and thus the student is unnecessarily awed by the supposed difficulty of its study. The dissection of brutes was not the only mode of obtaining a knowledge of anatomy in those rude and barbarous ages, for the sacrifice of captives afforded too many opportunities of acquiring such information from the human body itself.

The office of the liver is to secrete the bile. This fluid derives its name from two words meaning contention, as the ancients supposed it to be the cause of anger and dispute. It is formed, as before mentioned, from venous blood. When healthy it is of a yellowish green color, bitter taste, with an odor resembling musk, of the consistency of thin oil, and can be beaten to a froth. It has two principal offices, one the compounding of the chyle from the chyme, and the other that of acting as an excitant to the intestines, by which they are stimulated to throw off their contents. As it is constantly elaborating, a place of deposit for this fluid is found in the gall bladder,



THE LIVER, GALL BLADDER, PANCREAS, SPLEEN, AND KIDNEY

L L L L represents the liver, which is turned up, to show its under surface. It is divided into two large lobes, the upper portions of which are separated by a broad ligament, that helps to support the organ; between these large lobes, and lower down, lies a smaller one. The lobe on the right side is much the largest; G shows the gall bladder, whose duct may be seen in the engraving of the INTESTINAL TUBE joining that of the pancreas, so that the combined secretions pour at the same time into the duodenum; P P shows the pancreas; S the spleen; K K the kidneys, which pour their secretions into the bladder B by means of two long tubes; the uretus U U R is that lower portion of the intestinal tube called the rectum; V V the vena cava ascendens, running upward, of larger diameter than the aorta A, whose internal or fibrous coat is exposed and separated. The connection and mutual relation of the parts is finely shown in this engraving.

from which reservoir it is at all times ready, when called upon, to enter the duodenum.

THE PANCREAS is a gland deriving its name from its thick, fleshy consistence. It is some six inches long, and has been compared in shape to a dog's tongue. It lies behind the stomach. The secernents from its vesicles unite in one large tube to carry the pancreatic juice, which resembles in general appearance saliva, to the common duct of this organ and the gall bladder, which discharges into the duodenum. In the lower animals the pancreas is known as the sweet-bread, so called from its being considered a great delicacy for the table. It was formerly supposed that the pancreatic juice was merely useful in dilut ing the acridity of the bile, but some think it performs a much more important office, as it would seem a work of supererogation to have one secretion especially adapted to dilute another.

THE SPLEEN, or milt, is a gland of an oblong form, a spongy consistence, and livid color, convex toward the ribs, and concave internally. Its use has never been satisfactorily determined, and it varies so much in form, situation, and size, that it does not seem of any very great importance. It connects by so many vessels with the stomach, that some suppose it a reservoir of blood for that organ. A peculiar blueness of the white of the eye is said to indicate disease of the spleen.

THE KIDNEYS resemble in shape the bean of the same name. They are generally surrounded with fat, and have a peculiar structure, being composed of three kinds of matter; a thick envelope of vessels, ending in a series of long tubes, which in turn terminate in a series of minute nipples, from which the secretion flows into a funnel-shaped cavity that opens into the ureters.

THE MUCUS GLANDS are distributed in great numbers throughout the air passages and intestinal canal; their discharging tubes open on the surface of the mucus membranes, which take their name from the glands. The secretion is a transparent fluid of a glutinous, thready consistence and saltish taste; it is poured out on the membranes, covering them with a coating of greater or less thickness, according to their necessity, so as entirely to protect them from the action of the air, of food, and of the other glandular secretions, and answers toward them the same purpose that the cuticle does to the skin. It is mucus that runs from the nose when the membrane of the air passages is irritated, and it is the same substance that is blown from it in a dry or hardened state. When it lines any of the organs of the special senses, it favors their peculiar functions; thus it allows the olfactory nerve to smell with greater facility, the gustatory nerve on the tongue to taste with more acuteness, and assists the stomach and intestines in digestion.

THE HAIR GLANDS are small, oblong bodies whose tubes pierce the skin, sending out the long elastic filaments known as hair. These threads are composed of little cells, arranged in a tubular form, and filled with a colored liquid, the whole covered by a proper membrane. The hair is generally insensible, but in a disease common to

Poland, in the fall season, probably induced by want of cleanliness, it becomes hopelessly entangled, very sensitive to the touch, and sometimes bleeds. Curling hair seems to indicate in the system to which it belongs a similar tendency of the other fibers to assume the spiral form, and commonly denotes a peculiar springiness or elasticity of frame and constitution. The hair glands sympathize with all affections of the organism, and hence the hair often falls out during sickness, and is renewed upon the return of health. Cases have occurred in which grief and fear in a single night have each changed the color of the hair from a raven black to a silvery white. Fine combs should rarely be applied to the head; a good brush and the free use of water are the best means of preserving it in a healthy state, and restoring it when injured, care being taken to dry it well in every instance. Hair in the lower animals varies in quality from the finest down to the stoutest bristles, capable of supporting, it is said, even when a foot in length, the weight of ten pounds. Wool resembles hair, and is secreted by the same kind of glands, as is also the glossy silk of the Angora goat. In a similar manner is also secreted the beautiful plumage of the feathered tribes, each set of glands in the entire range of animated nature being peculiarly adapted to the wants of the individual to which they belong.

The Oil Glands are of quite small size, and lie embedded in the true skin, pouring out upon the surface an oily matter, by means of ducts that pierce the cuticle. The object of the secretion is mostly to protect the body from the action of the atmosphere, clothes, etc. So abundant are these glands where much needed, as on the face and neck, that when these parts are not kept properly cleansed, or when the digestive apparatus is out of order, great numbers of little black spots appear, which are occasioned by dust collecting at the orifices of the tubes;

the secretion in such cases hardens into a cheese-like matter, and when squeezed out, in consequence of taking the form of the ducts through which it passes, resembles little worms, by which name they are commonly known. When these black spots are neglected, and the cause of them, by attending to the laws of Hygiene, not avoided, the skin soon becomes rough and coarse, and the aspect of the countenance very repulsive.

At the root of each hair is a bunch of oil glands, whose tubes run along the inner surface of the membrane or sheath through its whole extent, to polish and lubricate the filament by the secretion they pour out. It is this oil that gives the fine gloss we see in many persons' hair, and is so abundant in some individuals as to grease whatever their head touches. The free, daily use of pure water, and moderate application of the brush, taking care to dry thoroughly every time, will almost invariably insure a supply of this fluid, and prevent the supposed necessity of purchasing the perfumed lard and colored sperm oil of the druggist, which so many foolishly buy under the names of bear's grease and macassar oil.

There are many little bodies in the system, of a supposed glandular nature, whose uses as yet have not been discovered; they are most probably of little comparative importance, and not necessary to mention in this place. Without entering into minute detail, it is enough to obtain a general and correct idea of the living economy.

As we progress in the study of Physiology we see abundant instances of the care nature takes in providing for the welfare of her children, and that this watchfulness extends not only to the individual as a whole, but to every part of the organism. The same contrivance that provides the oil glands to protect the tender skin of man from the wind gives scales and shells to the inhabitants of the deep, that the rough waves may sweep harmless around them. All share equally, from the animalcule to man, and we behold additional illustrations of that Power which

> "Breathes in our soul, informs our mortal part,
> As full, as perfect in a hair as heart.
> To Him no high, no low, no great, no small,
> He fills, He bounds, connects, and equals all."

CHAPTER V.

THE MEMBRANOUS SYSTEM.

Membranes of the Head—Membranes of the Chest—Membranes of the Abdomen—Nature of Dropsy and Method of its Cure—Accumulation of Fatty Matters—Daniel Lambert—Use of the Skin—Cuticle, its Structure and Uses—Cuticle of the Lower Animals—Rete Mucosum—Alteration of Color—Leopard and White Negroes—Cutis Vera, its Structure and Uses—Nerves of Touch—Corns and their Cure—Anatomy of the Skin—Perspiratory Glands and their length of Tube—Sanctorious' Teachings—Excretions of the Skin—Absorption by the Skin—Perspiration regulates the Temperature—Old Maxim in Medicine and its Application—Source of Animal Heat—Boutigny's Experiments—Naked Hand plunged in red-hot fluid Metal—Reflection and Radiation—Weight of Skin—Uses of Skins of the Lower Animals—Skin Extensible—Clothing.

Membranes have already been defined as compressed cellular tissue, serving mainly as coverings and linings for the different portions of the system. Besides this purpose they perform other important offices, as nature, unlike man, from one cause is able to produce many effects. Following the plan of the older anatomists, the dura mater will be first mentioned. It was called *dura* (hard) from its dense, opaque texture, and *mater* (mother) because they supposed all the other membranes to originate from it. It is double, covers the brain like a nightcap, is not sensitive, and adheres strongly to the smooth surface of the inner plates of the skull. The pia mater, or natural mother, lies below this, and runs into the divisions of the brain, giving a support to them and the blood-vessels that supply their structure; from the seeming care it thus takes it derived its name.

The pleura is the name of the membrane that lines the cavity of the chest and covers its organs. It is sometimes described as two membranes, which meet in the middle of the chest and divide it into parts, separating the three lobes of the right lung from the two lobes of the left, thus preventing their weight oppressing each other. It is very extensible, to allow the expansion and contraction of the lungs; but when inflamed, as in pleurisy, the motions of respiration, by stretching it, occasion those sharp pains known as stitches in the side. The pericardium is a membrane of similar nature, deriving its name from its office, that of covering the heart.

The peritoneum derives its name from the Greek, meaning to extend around; it is a strong, smooth membrane, continuous with the pleura, and descending through the openings of the diaphragm, enlarges to cover its inferior surface, and thence passing downward sheaths all the organs of the abdomen. Much fat is packed in its cells as it surrounds these parts, by which means, together with the support it gives, it not only keeps them from falling out of place by their own weight, but also prevents injury arising from ordinary concussions. The peritoneum sends off a prolongation of itself at the front surface of the spine called the mesentery (meaning the midst of the intestines), to fix the intestines and support their blood-vessels, nerves, lacteals, and absorbents.

It was observed before, in connection with the cellular tissue, that this elementary structure of the organism preserved, in all cases, the property of secreting from its surface a watery fluid to serve many important uses. These various membranes are constantly throwing off a serous exhalation, which, in consequence of disease, sometimes accumulates in the cavities to the amount of gallons, occa sioning much danger and annoyance. This state is called dropsy, and named from the part affected, as dropsy of the head or water on the brain, dropsy of the heart, dropsy of the chest, dropsy of the abdomen, and when all portions suffer, general dropsy. The trouble seems to be in an increased action of the secernents, and these once excited, continue to act and secrete a serous fluid from the blood in enormous quantities. It was formerly the opinion that dropsy was merely the deposition of the water drank, and the patient was forbidden its use, but it has been proved that when all fluids were denied, the parts continued to increase as before, and the prohibition was removed. Unless relief is speedily obtained, the system sinks under the terrible drain made upon its resources, and death is the inevitable result. The physician in his attempts to cure, gives medicines to stimulate the action of the absorbents, to enable them to take up the secretion.

In the same manner that the serous secernents produce dropsy, do those that secrete fat take on in some instances a diseased action, in depositing vast quantities of concrete oily matter in the cells of tissue. A certain amount is necessary for the comfort of the individual, as it cushions the skin, the eyeballs, and the other organs; but too much causes great inconvenience, and requires the same medical treatment to excite the absorbents as does dropsy. Those predisposed to it, no matter what their diet, if of the simplest vegetables, or even bread and water, still continue to increase alarmingly in bulk. Daniel Lambert, a noted character in this respect, nearly starved himself in early life to confine his system to moderate limits, but all in vain; the secernents continued to secrete fat, and as usual deposit it in the little cells, carefully closing and sealing each one, as the bees do honey in their combs, until the accumulation was so great that thus, in his own despite at first, although an occasion of much pride afterward, from the notice he incurred, he became the largest man of modern times.

THE SKIN has been described before, as a membrane covering the other parts, binding all together, and individualizing the body; that is, exactly defining the line of separation between it and other organisms. It is to the vitality of the skin or integument of seeds and the ova of animals that naturalists ascribe their protection from decomposition for long periods of time. Bomare relates a case in which he found three eggs, which, kept from the action of the air, had continued fresh in the wall of a church, where they must have remained over three hundred years.

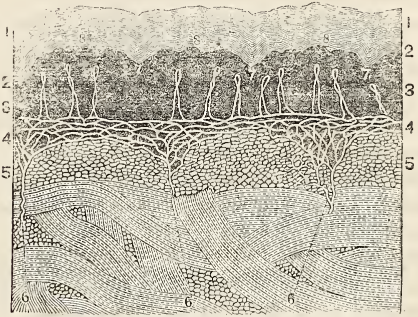
The skin of seeds, eggs, and many of the cold blooded animals, consists of two sheets of tissue, but warm-blooded animals have three coverings. The first or outermost of these is known in man as the CUTICLE, or scarf skin. When a blister is applied to the surface of the body, if its irritation is sufficient to inflame, we find a quantity of serous fluid effused under it, which has the effect of raising by its pressure a transparent membrane, resembling in appearance a very thin shaving of clear transparent horn; this is the cuticle. Its object, like the layers of mucus on their membranes, is to protect the parts acting as a shield to the nerves, blood-vessels, and glands that lie under it. It has no sensibility, a fact which may be ascertained by carefully inserting the whole length of a needle beneath it, or by pricking the narrow fold which it sends to line the base of the nail. Like mucus, its layer is more or less thick, according to the exposed position of the part it covers, being of a distinct horny character on the soles of the feet, and sometimes on the palms of the hands—the latter especially in blacksmiths and dyers, and all whose business subjects those members to rough usage. Many of the lower tribes of animals throw off the cuticle entire annually, and as often renew it. Serpents and spiders are examples of this; some vegetables, as the West India plane tree, do the same. In the human body it is not generally cast off in large portions at a time, unless by the application of blisters and exposure to the intense heat of the sun, but is continually ejected from the surface in the form of little scales, whose removal is much assisted by frequent bathing and washing.

THE RETE MUCOSUM, or mucus web, is the second or middle layer of the skin; so fine is the tissue of vessels composing it, that to both touch and sight it resembles a butter-like material. The secretion of this layer gives to animals their various colors. The frog and salamander are indebted to it for their beautiful shades; it tinges the shells of fishes and beetles; gives radiance to the insect tribes, and makes the plumage of the feathered creation delight us by its gorgeous dyes.

This middle layer has the power of altering its coloring at pleasure, to suit the changes of climate and temperature. The fair complexion of the Northerner becomes darkened by exposure to the sunny skies of the South, but is restored to its original whiteness by a return to colder climes. Much attention has been paid to this mucus web by physiologists, who adduce from its mode of action proofs of the unity of the human race. They find its color uniformly darker and darker as they approach the equator, and conversely becoming more and more bleached as they advance toward the poles. Seclusion and elevated situations are the only conditions that vary this rule. Moorish children of both sexes, when young, are said to be of equal fairness; but the boys, as they grow up and expose themselves to the sun and heat, lose it, while the girls, who remain at home, are as white as Europeans. In the interior of Africa are many nations varying in color according to their locality, from a red or copper hue to an olive and almost white. It is only the inhabitants of very low regions who are perfectly black; those who inhabit more elevated, and of course cooler and more salubrious positions, are fair in proportion. When a powerful blister has for a time removed the mucus tissue in a negro, the true skin lying underneath has appeared of exactly the same color as in the Caucasian. Disease of the rete mucosum has occurred, in which it has lost the power of secreting the black matter in various parts of the surface of the body, and from the other portions remaining the same, the whole has assumed a marbled or spotted appearance. Leopard negroes, as they are termed when thus affected, have been carried round the country for exhibition. Sometimes in this way the black man becomes white.

THE CUTIS VERA, or true skin, which lies undermost of all, is composed of bands of tissue, closely woven together, and sending threads to connect with the envelopes of fatty matter which lie beneath it, is of thinner texture in the front than back portions of the body. It sends off a fine transparent membrane, called the conjunctive, to cover the eyeball, and another for the drum of the ear. It seems a continuation of the same membrane that lines the intestinal canal and air passages, connecting with it at the mouth, so as to form one extended sheet. It is in consequence of this that a foul stomach often produces eruptions on the external skin, from the morbid action diffusing itself over the whole surface of membrane.

Embedded in the true skin, and supported by it, are blood-vessels, nerves, and various glands for the secretion of oil, hair, and perspiration. The unevenness apparent upon the surface of the skin is caused by immense numbers of little cone-shaped bodies, called *papillæ;* these are the terminations of the nerves that give the sense of touch. Those situated on the toes, when inflamed and enlarged, produce corns, and are oftentimes exceedingly painful and troublesome, but the means of cure are not difficult. If the cuticle is much hardened, is is best to carefully scrape it off, and, after removing it, put a little yellow or potash soap into the cavity, to stimulate the absorbents to take up what remains of the swelling after the scraping; but if it is what is called a soft corn, it can be protected from pressure, and thus from pain, by fastening around the part, with a little plaster, a piece of thick leather, having a hole cut in its center somewhat larger in size than the inflamed surface, and rubbing daily some yellow soap on the latter until relief is obtained.



SECTION OF SKIN, MAGNIFIED FIFTY DIAMETERS.

Fig. 1 1 shows the cuticle or external layer of the skin; 2 2 the rete mucosum, or layer for secreting the coloring matter; 6 6 6 nerves terminating to form a network; 4 4, whose loops 3 3 end in the papillæ 8 8 8; 7 7 7 the depression between the papillæ; 5 5 the cutis vera, or true skin, supporting the whole.

The perspiratory glands take their rise from the deepest portions of the true skin, sending their excretory ducts to pierce the rete mucosum and cuticle for the purpose of discharging upon the surface; their openings are called pores, and may be easily seen with a small magnifying power. Wilson tells us that he counted the pores on the surface of a square inch of the palm of the hand, and found that they amounted to 3528. As each one is the aperture of a twisted spiral tube, about one fourth of an inch long, the number in a square inch, if joined in one continuous tube, would make it over seventy-three feet in length, and allowing the surface of the body to embrace 2500 square inches, the whole extent of such a tube would be over THIRTY MILES.

Sanctorious, a celebrated Italian physician, who was appointed professor in the University at Padua, nine years after Harvey graduated there, has the honor of being the first one to point out the importance of the perspiratory system, and show the great amount of its excretions. He taught that five pounds out of every eight taken into the system passed off through the skin; but this calculation is too large for our climate; but even in the United States it is probable that the average of persons throw off by the pores over thirty ounces every twenty-four hours. As the sweat is not composed of pure water alone, but contains besides salty matters, which can not evaporate, and whose adhesion to the surface would not only tend to check this function, but besides irritate the skin, the necessity of frequent washing and bathing, at least daily, is readily perceived. Insensible perspiration may be made tangible by holding the apparently dry hand near a looking-glass, when a cloud will soon form on its surface. Some assert that the skin throws off carbonic acid as well as serum. It not only rejects but also absorbs; owing to the latter property, bathing in salt water quenches thirst, the pure fluid only being received, instinct rejecting the salty particles. Sailors, when the supply of water is limited, often wet their clothes for this object. The coloring matter of substances, as madder, is also often absorbed.

That other besides watery particles are thrown off by the skin is proved in the case of the contagious fevers, where the effluvia act in such a manner upon the persons with whom they come in contact as to induce in them the same form of disease. It is unsafe to be exposed even to the effects of human exhalations from healthy bodies; and hence the necessity of thorough ventilations in all apartments, especially those frequented by numbers of people. Many of the African race exhale an odor offensive to the Caucasian variety, whose emanations, as a general rule, are not so highly scented as to be perceptible to their own species, except when in a confined situation. Dogs, however, easily recognize it, and can pursue their master by the sense of smell over surprising distances, and even in a market-place, where thousands of other footsteps would seem to obliterate all traces of their owner's impress. Humboldt asserts the Indians have distinct terms to express the odor of a negro, a European, and a native American.

The skin not only discharges waste matters from its surface, but also performs another office, at least equal in value—that of regulating the heat of the body. We are indebted to Sanctorious for this discovery, and it was his investigation of it that probably led him to the invention of the thermometer.

It is well known that hot-blooded animals while in health preserve their respective temperatures in all situations. The cold-blooded are so named from varying little from the heat of the surrounding medium. This difference is often but a few degrees, and yet always exists wherever life is in active operation. Even trees will depress the thermometer in summer, and raise it in winter. The heat of man is ninety-eight degrees of Fahrenheit, and may be shown by holding the thermometer bulb in the hand, or putting it in the mouth, and while in either position examining the scale. As this degree is seldom or never reached by the atmosphere, even during the hottest summers in the shade, we must be all the time radiating caloric, throwing off more or less, according to the temperature around us. The skin, by its evaporation, controls this process. Every one is conscious of the relief experienced in warm weather by sweating. In proportion to the heat of the weather the amount of perspiration exhaled increases the grateful sensation of coolness. On the other hand, any cause that retards this process will occasion great distress and uneasiness. Thus, a heavy, warm atmosphere, already so saturated with water that it can take up no more, a close room, or woolen clothing in summer, induce on this account the most disagreeable feelings.

There is a principle in medicine, stated by one of the older physicians, that wherever irritation is excited on any part of the body, blood will flow to that part in increased quantities; and that, as a general rule, it will flow but to one place at a time. Advantage has been taken of this in family practice, by oiling the surface of the chest, in cases of severe colds, where the lungs are inflamed, and there is oppressed breathing. This oiling prevents evaporation; a great accumulation of heat ensues, until at last irritation is excited in the skin; the blood leaves the lungs and courses with rapidity to the surface, where its presence occasions but little comparative danger or pain; the internal organs, freed from congestion, work with their accustomed ease, and speedy relief is obtained. Nurses often oil the nose and portions of the face of children who have caught cold in the upper air passages, and with the same happy result.

The source from whence the system derives its heat has long been a problem to physiologists, and much pains has been taken to investigate the subject. When carbon or hydrogen unite with oxygen outside the system, heat is always produced. That they unite in the system we have the most undoubted proof by the fact that carbonic acid and water, both of which are products of their union, are thrown off; and that heat should not be produced as readily in one case as in the other we do not understand. Food, as before observed, has two objects, one to supply the waste of the body, and the other to furnish fuel for the production of animal heat; the latter purpose enables us to give a reason why a greater quantity of food, and of a more nutritious character, is required in the polar regions than in the tropics. The system being everywhere of the same temperature, in all its parts, would lead us to the capillaries as the place where heat is eliminated. Nature, by means of one cause, effects many results, and the incessant changes taking place in the vesicles render the supposition that the animal heat originates in them almost certain.

M. Boutigny has lately made some very interesting and important discoveries, which prove that the human skin may be protected from the effects of intense heat, in disorganizing it, simply by the moisture thrown off from the pores. He was led to the inquiry by considering the stories current in both ancient and modern times, of magicians who professed to walk on burning coals, or red-hot iron; and of some who were able to hold the latter in their hands, or between their teeth, or to plunge their hands into boiling water, or melted lead. He learned that at some foundries were workmen who had put their fingers with impunity into melted iron, but experienced great difficulty in verifying the fact. Finding, at last, a man who had performed this last feat without danger, he lost no time in repeating the experiment. He first divided, with his naked hands, a current of melted iron, which flowed from an aperture, and plunged his other hand into a vessel full of the metal almost white hot.

He shuddered involuntarily at the frightful venture, but both his hands came out safe.

The only precaution he considers necessary is to do it with such boldness that the hand may be passed with a moderate rapidity through the red-hot fluid. If too fearful, it may be done so slowly, or so swiftly, that in either case the repulsive force which exists between such bodies and the skin may be overcome, and the latter, by immediately touching the metal, be destroyed. In repeating the experiments afterward, he often covered his hands with a polish of soap, and then dipped them in water before subjecting them to the terrible ordeal. The explanation he gives is probably the correct one, and we will mention it in a simple manner.

It is well known that if two tin-pot covers are taken, the inside of the one brightly polished, and of the other blackened over the flame of a lamp, and both then placed at a little distance from the fire, different effects will result. The blackened surface will absorb the heat, and soon become very hot; while the polished one, in proportion to its brightness, reflects it, and is scarcely, if at all, warmed. When the hand is plunged into melted metal the skin is not in contact with the metal, and therefore the heat to which it is exposed is that of radiation. The moisture of the pores assumes the form of little drops or globules, which act as reflectors from every portion of their surface, and prevents the heat ever arriving at the boiling point. From the same cause a drop of water may be put on a plate of red-hot platina and it will remain without changing to vapor as long as the red heat is kept up, but if the platina is allowed to cool will vaporize directly. Probably the fear that the perspiration may turn to steam, and thus by removing the protection it afforded in the globular state, allow the instant destruction of the skin, if not of the whole hand—for all organized substances are decomposed at a red heat—will prevent many from following the example of the scientific Frenchman.

The skin, when separated from all the surrounding parts, is estimated to weigh about five pounds; but its thickness varies so much, even in the same person, that no average calculation can well be made of any value. Birds ordinarily possess the thinnest skins, and from them it varies in thickness, in the different tribes of animals, until, as in the case of the rhinoceros, the hide is proof against the attacks of swords, arrows, and musket balls. The skin of many animals, as of horses and cattle, whose integument possesses the requisite strength and elasticity, is manufactured into leather for many useful purposes.

The human skin is so extensible as to be capable of stretching to a great extent; in some portions, as about the neck and forehead, it possesses a degree of contractile power without the aid of muscular fibers. Many of the lower animals have skins capable of contracting and expanding at will, to enable them, among other uses, to cast off insects and similar annoyances. It is said that the skin of a horse shudders through every point at the sound of a whip. The skin of some birds enables them to move at pleasure the feathers of the crest and tail, and by this means the hedgehog can roll himself into a ball, and erect his bristles by way of defense.

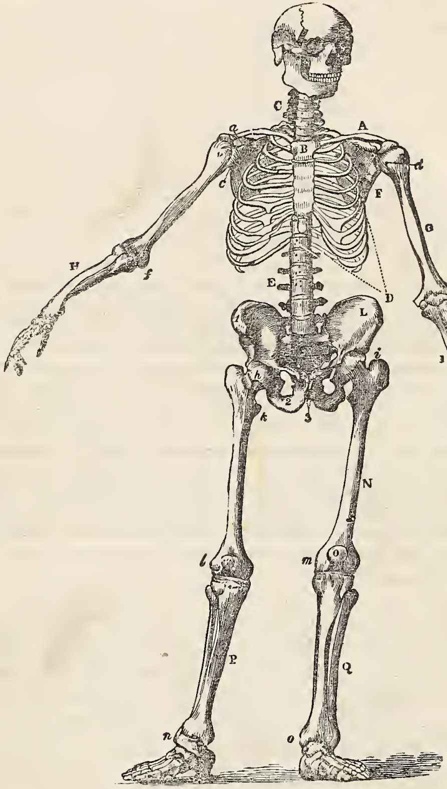
Linen underclothes, which absorb the perspiration with readiness, are the coolest in summer, and cotton or woolen the warmest in winter: in the latter season, light-colored overcoats, by radiating less heat than those of a darker hue, are the warmest. But it is well for every person to study the shades and textures that suit best the feelings in the changes of temperature, and wear such accordingly.

CHAPTER VI.

THE BONY SYSTEM.

Framework, and other Parts of the House of the Soul—Formation of Bone—Proof of the Particles changing in Bone—Time when Bones are fully Hardened—Hygiene of Bones—Perfect Modeling of Bone—Cuvier's Observations—American Horses before the Time of Columbus—The Mastodon, and its Habits—Number of Bones, and their Classes—Gravity of the Atoms of Matter—Engineer's Castings—Arrangement of Bones of the Skull—Strengthening of Bone—Anatomy of the Bones of the Head—Prevention of Injury—Bones of the Face—The Clavicle—The Sternum—The Scapula—Chain of Vertebræ—Body shorter at Night than in the Morning—English Recruits—Stooping of old Age—Division of the Trunk of the Body—Skull a large Vertebra—The Ribs and their Attachments—Motions of Respiration—Restoration of Drowned Persons—Sacrifices to Fashion—Arm, Hand, and Finger Bones—Bones of the Pelvis, and Lower Extremities—Names of Bones.

The body is the house of the soul, and, like other houses, possesses a framework that differs in many respects from that of fixed habitations, by the arrangements for locomotion. In carrying out the simile, we may represent the muscles as wheels, and the tendons as pulleys for moving the house; the stomach as the kitchen where food is prepared to afford nourishment to the owner; the lungs as perfect ventilators; the skin as an external porous covering to throw off waste matter by a system of sewerage, and at the same time having an oily matter poured upon it to protect the structure from the elements; and its coating of paint changing in color, according to the season, so as to be cooler in summer, and warmer in winter.



BONES OF THE FRONT SKELETON.

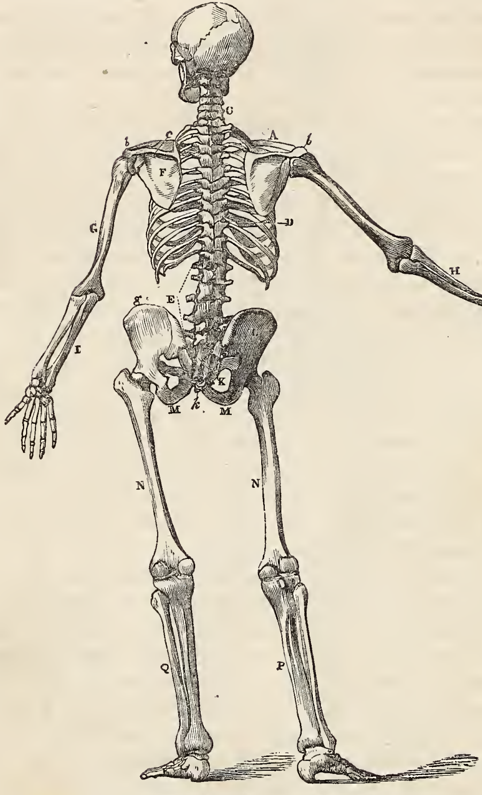
A clavicle, or collar-bone; B sternum, or breast-bone; C the seven cervical vertebræ; D the five false ribs, the seven upper ones being called true; E the five lumbar vertebræ; F scapula, or shoulder-blade; *a* coracoid process of the scapula; G humerus, or arm-bone; *c* head of the humerus; *d* a sulcus, or furrow, through which one of the heads of the biceps passes; *e* outer condyle of the humerus, from which arise the muscles that *extend* the wrist and fingers; *f* inner condyle: here arise the muscles which *bend* the wrist and fingers; H radius, I ulna—bones of the forearm; K os sacrum; L os innominatum; 1 the ilium; 2 os ischium; 3 os pubis; N femur, or thigh-bone; *h* head of the femur; *i* great trochanter; *k* lesser trochanter; *l* outer condyle of the femur; *m* inner condyle of the femur; O patella, or knee-pan; P tibia, largest bone of the leg; Q fibula; *n* external ankle; *o* internal ankle.

Throughout the entire house the nerves serve as bell wires, acting as a medium to receive and carry messages; thus connecting all the parts into one common whole, under the control of the proprietor.

When the life-power forms bone, it appropriates a portion of cellular tissue of the proper size, and at first fills its cells with gelatin, as an artist would make a model and perfectly finish his statue in clay before casting it in bronze. After the bone model is completed in exquisite taste and proportion, the hardening process commences; the gelatin is removed by the absorbents and phosphate of lime deposited in its place, except at the ends where the gelatin is hardened into gristle or cartilage to allow for the adhesion of ligaments, to bind and support the joints, and give a firm hold for the attachment and insertion of the tendons of muscles to move the bones. As a matter of course, from the preceding description, the bones have blood-vessels, nerves, secernents, and absorbents, their hardness and whiteness being due alone to the great quantity of lime they contain. Bones, like other parts, will bleed when injured and exposed.

That the bones share in the incessant changes of the system, has been proved by their acquiring a red tinge in animals whose food has been mixed with madder. In the course of a day the bones of young pigeons, thus fed, have changed to a rose color. By ceasing to give the madder, the natural hue is regained. This could not occur were not the coloring matter taken up by the absorbents.

That animal as well as earthy matter enters into the composition of bone may easily be proved by obtaining each in a separate form. At a red heat all animal compounds are resolved into their elementary atoms; so that a bone laid upon the fire may be baked to such a degree as to leave behind only its earthy composition, which still retains its shape, and does not fall to pieces unless dis-



BONES OF THE BACK SKELETON.

A clavicle, or collar-bone; C the seven cervical vertebræ; D the twelve dorsal vertebræ; E the five lumbar vertebræ; F scapula, or shoulder-blade; *b* acromion of the scapula; *c* spine of the scapula; G humerus; H radius, I ulna—bones of the forearm; K os sacrum; *k* os coccygis; L os ilium; M os ischium; N femur, or thigh-bone; P tibia, largest bone of the leg; Q fibula.

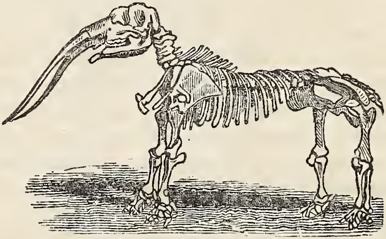
turbed. If immersed in a solution (one part to five) of hydrochloric acid in water, all the earthy particles will be taken up, and there will remain a mass, mostly of gelatin, the exact form of the bone, which may be removed from the solution and tied into a knot, or twisted in any shape, at pleasure.

The process of removing the gelatin and hardening the bone by phosphate of lime are not fully completed, as a general rule, until the age of twenty years. In the adult the amounts of earthy and animal matter are so exactly balanced that all requisite strength is afforded, and yet a degree of elasticity preserved sufficient to prevent injury arising from ordinary blows and concussions. Children, whose bones are quite soft, should not be allowed to carry heavy weights, nor remain for a long period in a standing position, as such circumstances tend to distort the bones, and often permanently alter the natural shape of the body. Jugglers and mountebanks attain the surprising facility they exhibit in twisting and bending backward by continued training in the practice of their tricks in early life, while the bones are flexible. Seats for children, especially in school, should always have backs to them, and be low enough to permit the feet to rest upon the floor; and care should be taken so to arrange their exercises that the position of pupils may often be changed, and nature thus permitted to develop forms of grace and beauty. The bones of old persons contain much less gelatin than when in middle life, and hence are easily broken by falls that would not have caused much inconvenience at an earlier period.

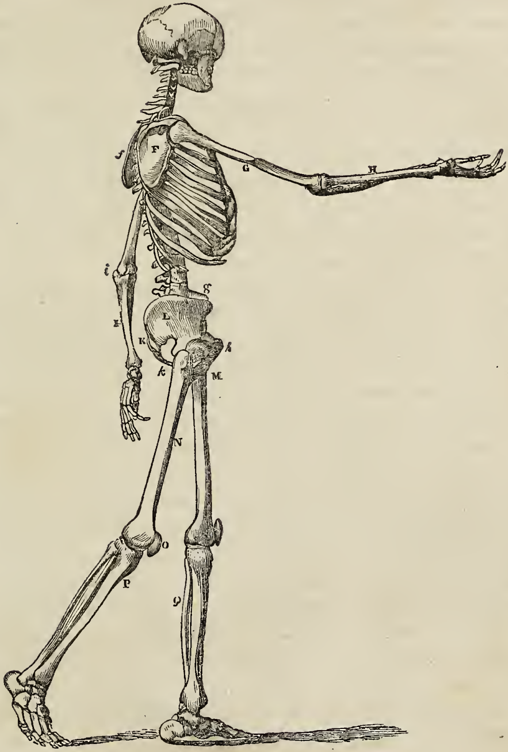
So perfectly does the life-power model the bone, and so nice is the care with which every little point and process is added for the performance of its offices in the animal economy to which it belongs, than an anatomist can tell, by examining it, the structure and habits of the being of which it formed a part. And even more than this, for Cuvier asserts that from only the extremity of a bone well preserved, attention, consideration, and the use of the resources which analogy furnishes to skill, may be determined all the rest as surely as if the animal were present.

It was in this manner, by finding the tooth of an extinct species of horse in South America, and comparing it with a similar one brought from the United States, that the English naturalist, Darwin, was enabled to prove that horses lived on the continent of America many ages before the Spaniards brought them over from Europe. Thus nature rewards her diligent students who faithfully study her records, and enables them to trace the existence of animals long after they have been lost, even in the traditions of the countries they formerly inhabited, as was the case in the present instance, for we are told that the Indians imagined, when they first saw the cavalry of Cortez, that the horses formed a part of their riders.

Among the various animals discovered by comparative anatomists, which are not found at present upon the surface of the earth, is the mastodon, that derives its name from the nipple-shaped protruberances on its teeth, which are all grinders. From this latter circumstance, in connection with others, it is believed to have fed upon the



SKELETON OF A MASTODON.



BONES OF THE SIDE SKELETON.

F scapula, or shoulder-blade; *f* base of the scapula; G humerus; H radius, I ulna—bones of the forearm; *i* olecranon; K os sacrum; *k* os coccygis; L os ilium; *g* spine of the ilium; *h* os pubis; M os ischium; N femur, or thigh-bone; O patella, or knee-pan; P tibia, largest bone of the leg; Q fibula.

soft parts of vegetables, to have taken up its food by means of a trunk, and to have inhabited marshy places. It is of enormous size, many times larger than the elephant, which animal it resembles in some respects.

There are in the human body some two hundred and forty-eight bones, and these are divided as follows: In the skull, 8; in the hearing apparatus, 8; in the face, 14; in the teeth, 32; in the spine, 24; in the hip, 1; in the coccyx, 1; in the tongue, 1; in the breast, 1; in the ribs, 24; in the upper extremities, 64; in the lower extremities, 62; sesamoid bones, 8; total, 248.

These have three classes: the long bones, which are found in the extremities; the short bones, which inclose cavities, as those of the skull; and the irregular bones, or those not included among the others. This division is not a very precise one, but perhaps the best that can be made.

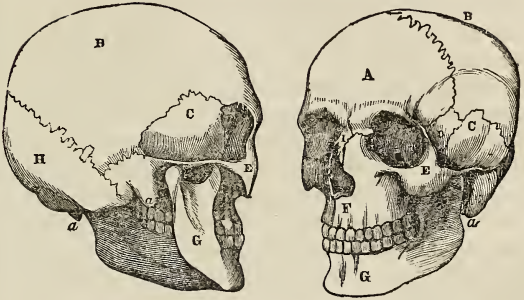
The atoms of matter used by the life-power are subject to gravity, the only one of the chemical and mechanical forces that exerts any control over them; but the yoke is lessened by the contrivance observed to make it as easy as possible, that the organism may be troubled with little weight to impede its movements. It is for this object the long bones are made hollow, and their cavities stored with marrow, to serve as depositories in the system of nutriment in times of need. The short or flat bones have only hard plates externally, their interior consisting of very loose cellular bony texture. This is a principle well understood by engineers, which induces them to cast hollow pillars and shafts, in order to gain greater strength without increased expense of metal.

At the joints the ends of the bones are bound together by means of strong elastic cords, or ligaments, which allow of all proper motion and yet prevent their separation. Besides these there is an elastic bag in each joint, which not only adheres with great force to the ends of each bone, but also continually pours out a thin oily fluid to remove any friction which might arise, another proof of the care of Providence to prevent disturbance in the working of the system. These bags are called synovial capsules, and sometimes by disease accumulate quantities of fluid (synovie), the effect of which is to push the bones apart and produce swellings of the joint. This morbid action is of the same nature as that causing dropsy, and requires the same plan of treatment, which is stimulation of the absorbents.

The bones of the skull are so arranged as to assume an arched form in all the superior portions, and thus have increased power to resist injury, for the more effectual protection of the brain. The external plates are very tough and rugged, and connected at their junctions at the seams, or sutures, by a kind of dovetailing, as carpenters join fine pieces of wood. This kind of suture would limit a fracture in ordinary cases extending beyond it; and the effect of a blow would be still further diminished before it reached the internal plate by passing through the loose cells, so much so, that the outer plate is often broken without the inner one being disturbed. The internal plates are smooth and marble-like, so as not to irritate by any roughness the brain or its membranes. Not admitting of dovetailing on account of their glassy texture, they merely lie adjacent to each other at the sutures. Much use is made of the peculiar formation of the skull by writers on natural theology.

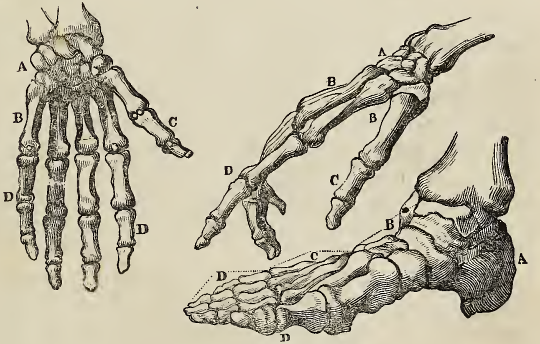
For the same purpose that mechanicians insert metal or pieces of very strong wood into the portions of beams intended to bear the greatest strain, so enamel-like ridges of extreme hardness are formed on bones wherever necessary to enable them to perform their offices with safety and surety.

In the Caucasian variety of the human race, the head is of a more oval form than in any other, and the forehead higher and more bulging. The forehead bone (os frontis) resembles in shape the undervalve of a scallop shell, and is situated in front of the head, assisting to form the roof of the orbits and the nose; its plates separate at the lower portion of the forehead, and no bony cells, as with the others, intervening, cause a cavity called the frontal sinus, which communicates with the air passages and is lined by the same membrane; it is supposed to give increased depth to the voice. The side bones (ossa parietalia, from paries, a wall) are somewhat square in shape, rather arching, and form by their junction with each other most of the superior arch of the skull. The temple bones (ossa tempora) are situated at the side and base of the skull; they are named from a word meaning time, because it was supposed that the hair turned gray on this part sooner than elsewhere. Each has three prominences: one called the zygoma, or yoke, as it extends forward to form an arch with the malar bone of the face; another, the styloid, or pen-like, from its resemblance to the pointed instruments used by the ancients in writing; and a third, the mastoid, so called from its nipple-like shape; this last is internally composed of very loose bony cells, and as it is connected with the apparatus of hearing, probably helps to intensify sounds. The occipital bone (os occipitis) is thicker and stronger than any other in the head, because less protected; if we fall forward the hands are thrown out to save the forehead; if sideways, the shoulder wards the parietal bones; but if backward, the occiput incurs the full effect of the injury; it forms the lower and back portion of the brain case, and has a large hole to permit the spinal marrow to pass downward into the canal of the vertebral column. The sphenoid bone (os sphenoides, meaning *wedge-like*) has been compared in shape to a bat with outstretched wings; it is the most internal of all, and connects the lower bones, seeming to wedge the whole together.



BONES OF THE HEAD.

A os frontis, or forehead bone; B B ossa parietalis, or bregmatis; C C os temporum; D D os sphænoideum; *a a* the mastoid process; E E os jugale, or os malare; F F maxilla superior, or upper jaw; G G maxilla inferior, or lower jaw; H os occipitis, or back of head; I os nasi.



BONES OF THE HAND AND FOOT.

Bones of the Hand.—A bones of the carpus, or wrist; B bones of the metacarpus, or hand; C bones of the thumb; D bones of the fingers.

Bones of the Foot.—A os calcis, or heel bone; B tarsus, or instep, composed of six bones besides the os calcis; C bones of the metatarsus, or foot; D bones of the toes.

The cheek bones (ossa julgalæ, meaning a yoke), lie under the eye and floor the orbit. The upper jaw bone (maxilla, meaning to chew) takes up the greatest portion of the face; its lower and front projection has a kind of semicircular sweep to hold the sockets of the upper teeth. The nose bone (os nasi) forms both the bridge and base of the nose. The under jaw bone is shaped like a horse shoe, with a sweep corresponding to the upper, for the alveoli of the lower teeth. The tongue bone (os hyoides, named from a Greek letter) supports the root of the tongue and gives origin to muscles acting on the larynx and adjoining parts.

The clavicle, or collar bone, was so called from its resemblance to an ancient key; it is placed at the root of the neck and upper part of the breast, extending across from the tip of the shoulder to the upper part of the sternum, thus forming an arch to protect the shoulders and prevent them from falling forward upon the breast, and making the hands strong antagonists of each other, which, without this steadying, they could not have been.

The sternum, or breast bone, is some seven inches long; besides serving as the origin of several muscles, it has other uses, defending the heart and lungs; and it has been remarked as worthy of notice, that a similar bone is found in almost all animals that have lungs, even where the ribs are absent, as in frogs; in man, the true ribs are inserted into it.

The scapula, or shoulder blade, is triangular in form, and placed like a buckler on the upper part of the back and side of the chest, occupying the space from the second to the seventh rib; it has many processes for the attachment of muscles; the acromion process is so named from being the extremity of the shoulder; it is very broad and flat; the coracoid process resembles the beak of a crow; its hook helps to prevent the arm bone from leaving the shoulder joint.

The spine is the central column or pillar of the human house; it rests upon the hip, supporting the entire upper portion of the body, and having a canal grooved through its center for the reception of the spinal marrow. It is composed of small bones called vertebræ, whose name is derived from a word meaning to turn on account of their motions. Each vertebra has seven processes for the attachment of muscles, and other uses. Strong ligaments connect the chain of them together. Between each is a compressible, cork-like substance, to allow a certain amount of bending and twisting of the body and yet permit no strain on the nervous cord within. The weight of the upper part of the body pressing on this gristly matter during the day, accounts for the singular fact that persons are always shorter at night than in the morning; in tall young persons the difference will often be an inch or more. There is a class of men in England, who receive a certain reward for every recruit they bring to the British army. When such men find a person willing to enlist, but wanting an inch or a little more of the requisite standard height, they put him to bed, feed him well and make him drink freely of fluids, and in a day or two, by thus causing the cartilages between the vertebra to swell to their utmost extent, succeed in their object—the recruit passes with ease the ordeal of stature, and his keeper receives the desired premium.

As old age approaches, these cartilages become dry and shriveled, retain their compressed state, and the body is permanently bent and shortened. At its upper portion the column of vertebræ projects a little forward, to support the head, which, without this assistance, would need a much greater number of muscles, giving the neck a very clumsy appearance. Below the neck the column curves backward, to enlarge the cavity of the chest and afford more room for the heart and lungs; below the chest it again curves forward in the line of gravity to keep the body in an erect position, for without this provision we should be constantly liable to fall forward; below the abdomen it again curves backward, to help form the cavity of the pelvis.

The trunk of the body is divided into three parts: the first is the chest, inclosed by the true ribs and bounded by the diaphragm below; the second is the abdomen, bounded above by the lower surface of the diaphragm, the floating ribs and spine on the back and sides, and muscles in front; the third is the pelvis, or basin, whose cavity is formed by the hips and bounded below by the coccyx.

One of the earlier writers in describing the spine gave a very good idea of its relation to the skull, by considering the latter as a vertebra of great dimensions expanded and enlarged to hold more nervous matter than any of the others, and having processes on its front surface for the attachment of the bones of the face.

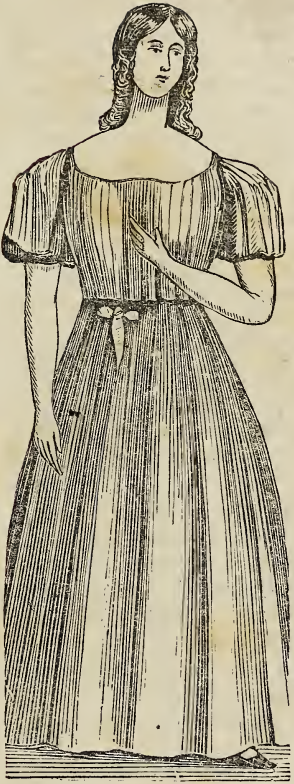
There are twenty-four ribs, twelve on each side, and these are divided into true and false: *true* when only a small cord of cartilages attaches them to the breast bone—of these there are seven; *false* when floating loosely and attached to the breast bone by long cords. All of them have a regular hinge joint with the vertebra, to allow of short motions necessary in respiration. Their use is to cover and defend the lungs and heart, give origin to muscles, and assist in breathing.

In respiration the inspiratory movements are performed by the depression of the diaphragm and slight elevation of the ribs; this enlarges the cavity of the chest, and producing a partial vacuum, causes the air to rush in and fill it; in the expiratory movement the diaphragm is pushed upward by the pressure of the abdominal organs, which recede before the contractions of their muscles, the previously strained ligaments of the ribs contracting so as to resume their natural tension, and thus reducing the chest to its usual size.

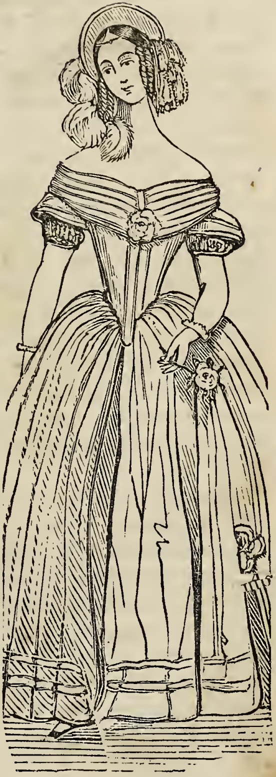
In the restoration of drowned persons the great object is to establish respiration, and this is attempted at first artificially, by imitating the mechanism of the natural function. The nose is tightly compressed, the lips of the operator placed in close contact with the patient, and air blown into the lungs until the chest expands; this air is thrown out again by pressing the abdomen strongly upward, and leaving the mouth and nose open. These motions are successively repeated until signs of life appear or all hope of recovery abandoned. The body should be laid during this time in hot blankets, constantly rubbed with warm hands, and the head and chest raised higher than the other parts. On the first signs of revival it is well to pour some stimulant down the throat. It has been proved that until absolute death takes place, not a drop of water enters the lungs, the fluid being perfectly excluded by the instinct of the larynx closing its passage tightly; hence the old method of rolling in a barrel, and holding the head downward, for the purpose of letting the water pour from the lungs, has been abandoned. This process was almost sure to kill of itself, by inducing congestion of the brain.

The clothes of children should always be loose and easy, that no undue compression may be made on any part, and nature allowed to develop the peculiar type of each. In the case of girls this is often purposely prevented, as fashion decrees small waists for women, and to procure such tight stays are often worn from an early period. The gelatinous matter moulds itself to conform to the stays, and, of course, the phosphate of lime, when deposited in its place in the little cells, retains exactly the shape of the model; the desired object is attained, and the young lady has a permanent wasp-like waist of the wished-for contracted circumference. It is no wonder that the disposition as well as the waist resembles the insect, for irritated nature exacts the penalty due to her violated laws. Health is sacrificed; not only the lungs, but also the organs of the abdomen, suffer throughout life; and a morbid sensibility is the inevitable result. It has often been noticed that in diseases of the chest, as consumption and enlargement of the heart, that the whole tone of the system became elevated in proportion to their danger—a refining process, as it were, taking place to prepare the being for a more glorious stage of existence; but the direct opposite of this occurs where the stomach, liver, or spleen are involved; the tone is lowered; moodiness and peevishness replace hopeful and pleasant frames of mind, and the least trifle causes the manifestation of the utmost annoyance. The victims of fashion in this respect, if they escape consumption, can not avoid the latter affections, and are doomed to the endurance rather than the enjoyment of existence. After all the pains and suffering undergone, the distorted girl, although covered with jewels, can not really vie in appearance with one more judiciously trained, even when the latter is attired in the simplest manner, and without any ornament.

The arm bone (os humerus, meaning the shoulder) fits by its upper head into the cavity of the shoulder joint. The bones of the fore arm are the radius and ulna; they terminate at the wrist (carpus), which is composed of eight small bones, to allow all necessary motion, and yet retain sufficient firmness. The bones of the hand (meta carpus, meaning after the wrist) are ten in number, and end at the first row of phalanges, or small bones of the thumb and fingers, which are named from their appearance in rows, like soldiers.



NATURE.



ART.

The pelvis (basin) is composed in the adult of four bones: the sacrum, behind, so called as it was the part of animals anciently offered in sacrifice; it is formed of vertebræ, having the spaces between them filled with bony matter instead of cartilage, as motion would be injurious in the pelvis; the coccyx, below, named from its resemblance to a cuckoo's bill; and the two ossi innominata (nameless bones), on the sides; this was originally composed of three bones: the ischium, the ilium, and the pulis, which, growing together in one, left the whole without a name (innominatum). The thigh bone (os femoris, from femor, the thigh) has two large processes, called trochanters (trotters), because in them the muscles are inserted that enable us to walk or run; by this contrivance the body is supported, a graceful shape retained, and every proper motion easy to perform. The tibia and fibula form the leg bones; the tarsus, or instep, is composed of seven bones firmly united to each other; succeeding these are the five metatarsal bones, followed by the phalanges of the toes.

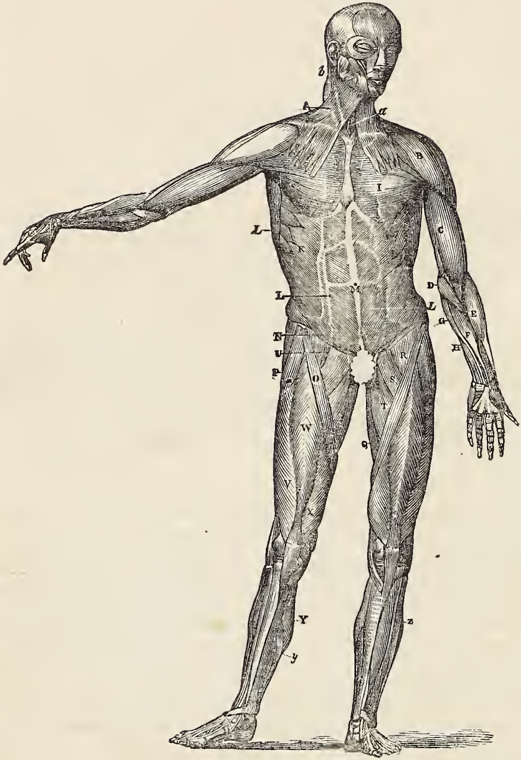
The names of the bones will generally teach the names of the other parts situated on them, so that a little attention bestowed on them at the outset will cause most of the difficulties attending the nomenclature of anatomy to vanish. Thus the radius has the radial artery, radial vein, and radial nerve passing over it; and the ulna has the ulnar artery, ulnar vein, and ulnar nerve passing over it; the muscles attached to the bones also generally take their names from them, so that a knowledge of the bones makes all the rest easy to acquire.

CHAPTER VII.

THE MUSCULAR SYSTEM.

Diffusion of Mobility—Organs of its Concentration—Formation of Muscles—Mode of their Contraction—Physiology of Muscular Contraction—Loss of Power by the Position of Muscles—Immense Strength of Muscles—Topham, and his Performances—Muscular Powers of the Lower Animals—Arrangement of Fibers of Muscles—Origin and Insertion of Muscles—Hindoo Devotees—Effect of Seclusion—Conditions necessary for proper Development of Muscles—Hygiene of Muscles—Antagonism of the Flexors and Extensors—Diseased Actions, and their Method of Cure—Operation for Strabismus—Buffoon Muscles—The Erect Position most Natural—Directions for holding the Pen — Physiognomy — John Bulwer — Mademoiselle Clairon — Sir Charles Bell's Theory of Expression—Bell's Criticism on the Dying Gladiator.

Mobility, or the power of motion, is inherent in every part of the living frame, for without it the necessary series of changes could not take place in the organism. As one of the properties of the vital principle common to both kingdoms, it must exist wherever that subtile essence is present, from plants to man. It permeates all the tissues and enables them to perform their functions. Where the frame is fixed, as in vegetables, nothing more is necessary; but animals which change their places, and require great capability of motive power, are endowed with organs for its concentration, as we find that nature always provides special apparatus for increased and peculiar exertion; these organs are called muscles, and compose the lean meat of animals.



MUSCLES OF THE FRONT FIGURE.

A Platysma Myoides (broad muscle) arises from the cellular covering of the upper part of the deltoid and pectoral muscles, and runs obliquely upward, along the side of the neck; inserted into the lower jaw between its angle and the origin of the depressor anguli oris. *Use*—to assist the depressor anguli oris; and also draws up, when the mouth is shut, the skin to which it is connected, below the lower jaw.

B Deltoides (shape like the Greek letter Δ) arises from the outer part of the clavicle, from the spine and acromion of the scapula. It is composed of several lobes or parcels of flesh, which all join in one tendon, and are inserted into the outside of the humerus, four fingers' breadth below its head. *Use*—to raise the arm, and assist it in every motion, except that of depressing it.

C Biceps arises by two heads, one of which proceeds from the upper edge of the scapula; they both unite about the middle of the arm, and make one swelling, which is inserted, by a strong round tendon, into the tuberosity at the upper end of the radius *Use*—to bend the forearm.

I Pectoralis (Pectus, the breast); arises from part of the clavicle, from the sternum, and from the six upper ribs, and is inserted, by a strong tendon, into the humerus, four fingers' breadth below its head. *Use*—moves the arm forward, and upward toward the sternum.

K Obliquus Descendens (descending oblique) arises from the last two true and the five false ribs, by five or six digitations, the four uppermost of which lie between the teeth of the serratus major anticus; it descends obliquely, by a broad and very thin tendon, and passing over the rectus, is inserted all along the linea alba, to the upper and fore part of the spine of the ilium, and to the fore part of the os pubis. *Use*—assists in expiration, and occasionally in discharging the contents of the stomach and belly.

L Rectus (straight) arises from the sternum, and the last two true ribs, and is inserted into the os pubis. *Use*—raises the body when we lie on the back, and sustains it when bent backward. It has three or four nervous or tendinous intersections or bands, which divide it and make it appear like several muscles; the third of these bands is not in every body exactly in the same place, it being sometimes even with the navel, and sometimes higher; sometimes there is one of these bands below the navel.

O Sartorius (Sartor, a tailor) arises from the upper and fore part of the spine of the ilium, and descending obliquely over the thigh, is inserted into the inner and upper part of the tibia. *Use*—crosses the legs, in the manner tailors are used to sit, and hence it has its name.

P Tensor Vaginæ Femoris (stretcher of the sheath of the thigh). This, covered by it, stretches the membranosus, or fascialis, which arises from the upper and fore part of the spine of the ilium; its fleshy part terminates at the great trochanter, where its membranous part begins, and, spreading itself over the muscles of the thigh, passes to its insertion on the upper part of the tibia. *Use*—draws the legs and thigh outward.

Q Gracilis (slender) arises from the os pubis, near its articulation, and is inserted into the upper and inner part of the tibia. *Use*—helps to bend the leg, and assists in bringing it and the thigh inward.

T Triceps—is named from having three heads; the first and second arise from near the articulation of the os pubis, and the third from the tubercle of the ischium; they are inserted all along the spine of the femur. *Use*—pulls the thigh inward.

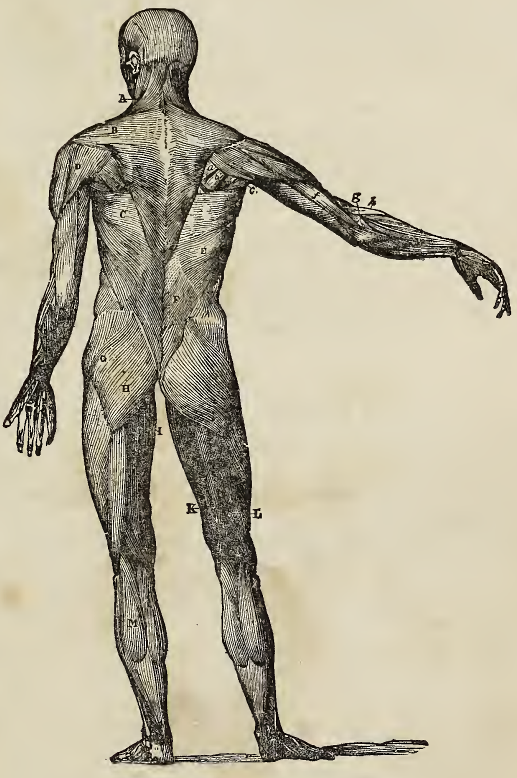
V Vastus Externus (external large muscle) arises from the great trochanter and external part of the femur, and is inserted with the following muscles. *Use*—extends the leg.

W Rectus Femoris (straight muscle of the leg) arises from the lower part of the spine of the ilium; this and the two muscles V and X, just above the knee, make one strong tendon, which passes over the patella, to which it adheres, and is inserted into the upper part of the tibia. *Use*—extends the leg.

X Vastus Internus (internal large muscle) arises from the lesser trochanter and internal part of the femur, and is inserted with the rectus femoris. *Use*—extends the leg.

When a figure stands upright, and rests on one leg, there appear above the knee certain swellings, which are made by the tendon of the last three muscles and the skin, and which disappear when the knee is bent.

Y Gastrocnemius (stomach, belly, or calf of the leg) has two distinct fleshy originations from the hindermost part of the two protuberances of the thigh bone; in their descent they are dilated into two fleshy bellies, the innermost of which is thickest and largest, and, joining together, make a broad, strong tendon, which unites with the tendon of the soleus, and is inserted with it. *Use*—extends the foot.



MUSCLES OF THE BACK FIGURE

B TRAPEZIUS (four-square, or cucullaris, hood-like) arises from the hinder part of the head, from the spines of the vertebræ of the neck, and the eight upper ones of the back, and is inserted into the spine and acromion of the scapula and the clavicle. *Use*—to move the clavicle, scapula, head, and neck. This muscle, passing over the scapula, contributes very much to a certain roundness we see in that part.

a INFRA SPINATUS (beneath the spine) arises from the cavity below the spine of the scapula, and filling that cavity, is inserted into the humerus, a little below its head. *Use*—draws the arm downward and backward.

b TERES MINOR (lesser round muscle) arises from the inferior costa of the scapula adhering to the capsular ligament, and is inserted into the outside of the external tubercle of the humerus, below the infra spinatus. *Use*—to roll the humerus outward, and to draw it backward.

c TERES MAJOR (greater round muscle) arises from the lower angle of the scapula, and is inserted into the humerus, with the latissimus dorsi. *Use*—helps to draw the arm downward and backward.

f GEMELLUS, or TRICEPS BRACHIALIS (double or three-headed muscle of the brachius, the old name for the arm bone) is composed of the brachius externus, which arises about the middle and hinder part of the humerus; the musculus longus, which arises from the lower side of the scapula; and the musculus brevis, which arises from the hinder part of the humerus. These three make one tendon, which covers the elbow, and is inserted into the hinder part of the olecranon. *Use*—to extend the forearm.

C LATISSIMUS DORSI (broad muscle of the back) arises from the hinder part of the spine of the ilium, from the upper spine of the os sacrum, from the spines of all the vertebræ of the loins, and from the seven lower ones of the back; it passes by the lower angle of the scapula, to which some of its fibers are fixed, and, joining with the teres major, is inserted with it into the humerus, three fingers' breadth below its head. *Use*—helps to draw the arm downward, and obliquely backward. This muscle, at its origin, is so thin that it does not hinder your seeing the action of the muscles that are underneath it, but toward its insertion it becomes very thick and fleshy.

E Sacro Lumbalis—arises from the upper part of the os sacrum, and back part of the spine of the ilium, and is inserted into the back part of the ribs, near their root.

F Longissimus Dorsi (long muscle of the back) arises from the same origin as the last muscles, and is inserted partly into the processes of the vertebræ of the back, and partly into the ribs.

The last two muscles keep the body erect, bend it backward, and sustain it when bent forward, and when they act only on one side, they draw the body sideways. Although these last two, and the splenius, are entirely covered by the trapezius and latissimus dorsi, their action and shape appear very plainly.

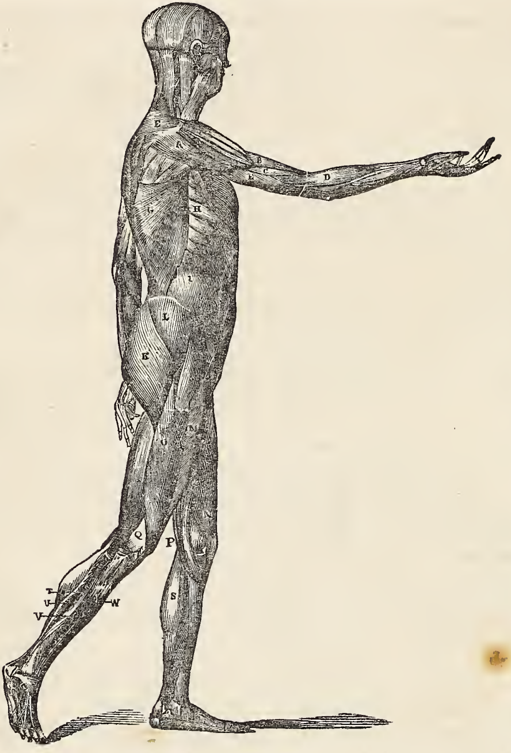
G Glutæus medius (medium muscle of the buttocks) arises from the spine and dorsum of the ilium, and is inserted into the back part of the trochanter major. *Use*—to pull the thigh outward, a little backward, and rotate it inward.

H Glutæus Maximus (largest muscle of the buttocks) arises from the external surface of the ilium, from the os coccygis and os sacrum; and is inserted into the thigh bone, a hand's breadth below the great trochanter. *Use*—to extend and rotate the thigh inward.

I Semitendinosus—arises from the protuberance of the ischium, and is inserted into the inner part of the tibia, below its articulation with the fibula. *Use*—helps to bend the leg.

K Semimembranosus—arises from the protuberance of the ischium, and is inserted into the upper and back part of the tibia. *Use*—helps to bend the leg. N.B. These last two muscles form the inner hamstrings.

L Biceps Femoris—arises by two heads, one of which arises from the tuberosity of the ischium, the other from the linea aspera of the thigh bone; they both join together, and are inserted, by one tendon, into the upper part of the fibula. *Use*—helps to bend the leg, and is likewise employed in turning the leg and foot outward, when we sit down. N.B. This muscle forms the outer hamstring.



DESCRIPTION OF THE REMAINING MUSCLES, AS SHOWN ON THE SIDE FIGURE.

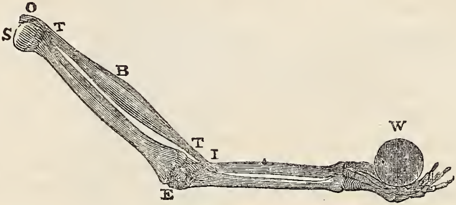
C Brachialis internus (inner muscle of the arm)—this is partly covered by the biceps—arises from the middle and internal part of the humerus, on each side of the deltoides, and is inserted into the upper and fore part of the ulna. *Use*—to bend the forearm.

H Serratus major (arising from serrated portions) arises from the six lower true ribs, and from the first and sometimes the second of the false ones, by so many distinct portions, resembling the teeth of a saw, and is inserted into the base of the scapula. *Use*—moves the scapula forward, and when the scapula is forcibly raised, to draw the ribs upward.

Wherever a muscle is needed in the system, the life-power, as in the case of bones, appropriates a distinct portion of cellular tissue for its construction, and fills the cells with fibrin and a small proportion of osmazome, secretions already described in the account of the glandular system. This apparatus is only present where great concentration of force is wanted, and hence anatomists, by not keeping in mind the general diffusion of mobility, have been at a loss to explain contractile motions in various parts of the organism where fibrin was not found. To look for it on every such occasion is like seeking a steam engine to draw a baby's wagon when the hands alone are sufficient to give it proper impetus.

As the cells in which the fibrin is packed retain the property of throwing off from their surfaces a watery fluid, every tendency to friction is perfectly obviated; besides this the muscles are covered with distinct sheaths, to separate them from other parts and permit their free working without disturbing the rest. The little cells are joined together in long lines or threads, the ends of which, instead of being filled with fibrin, are compressed into cords or tendons which fasten into the gristle of the bones their muscles are intended to move. Some, like the heart, have no tendons, being entirely composed of fibrin and cells. In the bones the phosphate of lime hides the blood-vessels, but the tissue of muscles allows them to be distinctly seen, hence the bright red appearance they present.

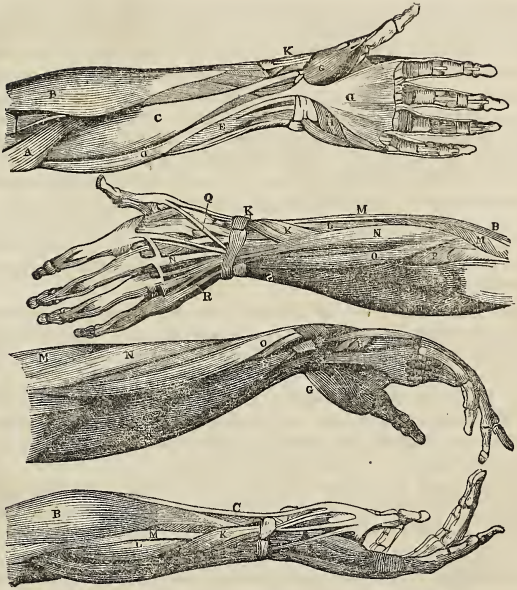
The muscles under the control of the will are intimately connected with the brain by means of nerves which ramify through their whole structure and terminate in the little cells. When the will directs a motion to be performed, the order is carried by the nerve which communicates its message in a peculiar manner by exciting the agent that controls the cells; a change instantly ensues in the entire substance of the organ, which contracts or thickens, bringing its ends nearer together, and thus moving the bones to which the tendons are connected. This hardening of the muscles may be felt by grasping with the hand of one side the forearm of the other while its fingers are bending.



MUSCULAR ACTION.

This engraving represents the bones of the arm, forearm, wrist, hand, and fingers, having all the soft parts dissected off, with the exception of one muscle O B I whose office it is to bend the arm; O the origin of the muscle; B the swelled portion filled with fibrin; T T the tendons or compressed cells destitute of fibrin; E the elbow, formed by the olecranon process of the ulnar bone; S the shoulder joint. When the muscle contracts the tendons approach each other; the lower extremity I is brought toward the fixed point O, and thus by bending the arm at the elbow joint raises up the weight W which is placed in the ball of the hand. In proportion as the end I is attached nearer to W will less power be needed in raising it to any given height, and the farther it is removed the more power is necessary; inserted where it really is, we can see that something like only one twentieth of its power can be used; thus if W weighs ten pounds the force employed to raise it is equal to two hundred.

It has been too much the custom to consider the bones and muscles as mere mechanical contrivances, governed solely by the same laws that prevail outside the body. The muscular system completely disproves this view, for in many cases in its arrangement strength is sacrificed to beauty and convenience, as in the muscles that bend the arm and straighten the ankle. Yet the loss of force is due to position alone, for inside the system, as well as out of it, size is the measure of power, other things being equal.



HOWLAND.

MUSCLES OF THE FOREARM AND HAND.

A **Pronator Teres**—arises from the inner protuberance of the humerus, where those bending the wrist and fingers arise, and descends obliquely to its insertion, a little above the middle of the radius. *Use*—to roll the radius internally, with the hand inward.

B **Supinator Radii longus**—arises from the ridge of the humerus, above the outer protuberance, and is inserted into the lower part of the radius. *Use*—rolls the radius outward, and consequently the palm of the hand upward.

C **Flexor Carpi Radialis**—arises from the inner protuberance of the humerus, and upper and fore part of the ulna, and is inserted into the first bone of the metacarpus that sustains the forefinger. *Use*—this, and the flexor carpi ulnaris, bend the wrist and hand.

D PALMARIS—arises from the inner protuberance of the humerus, and passing by a slender tendon to the palm of the hand, expands itself, and is inserted into the bones of the metacarpus, and into the first bones of the fingers. *Use*—helps the hand to grasp any thing closely.

E PERFORATUS, and PERFORANS, is the mass of flesh that appears under the flexor carpi radialis and palmaris. The perforatus arises from the inner protuberance of the humerus, and from the radius and coronoid process of the ulna, and is divided into four tendons, which are inserted into the second bones of the forefinger. Just above their insertion they are perforated, or split, to give a passage to the tendons of the perforans, which arises from the upper part of the ulna, and is likewise divided into four tendons, which pass through the perforations just mentioned, and are inserted into the third bones of the forefingers. *Use*—to bend the fingers.

N. B. The muscles of the forearm are never so strongly marked as when the hand is shut, or grasps something with all its strength, because then the internal muscles acting, the external ones are swelled more than ordinary.

K EXTENSOR POLLICIS—arises from the hinder part of the middle of the radius and ulna, and passing obliquely over the tendon of extensor carpi radialis, is inserted, by two or three tendons, into the bones of the thumb. *Use*—extends the thumb.

L EXTENSOR CARPI RADIALIS BREVIS—arises from the outer protuberance of the humerus; inserted into the root of the metacarpal bone of the little finger.

M EXTENSOR CARPI RADIALIS LONGUS—arises from the outer protuberance of the humerus, and is inserted into the bones of the metacarpus that sustain the fore and middle finger. *Use*—the above two extend the wrist and hand.

N EXTENSOR DIGITORUM—arises from the outer protuberance of the humerus, and from the outer part of the radius and ulna at the wrist; it is divided into three tendons, which are inserted into the bones of the first three fingers. *Use*—extends the fingers.

O EXTENSOR CARPI ULNARIS—arises from the outer protuberance of the humerus and ulna; inserted into the root of the metacarpal bone of the little finger. *Use*—to extend the wrist and hand.

P ANCONEUS (elbow muscle) arises from the back part of the outer protuberance of the humerus, and is inserted into the ulna, four fingers' breadth below its head. *Use*—helps to extend the arm.

S FLEXOR CARPI ULNARIS—arises from the inner protuberance of the humerus and ulna, and is inserted into the little bone of the wrist. *Use*—this and the flexor carpi radialis bend the wrist and hand.

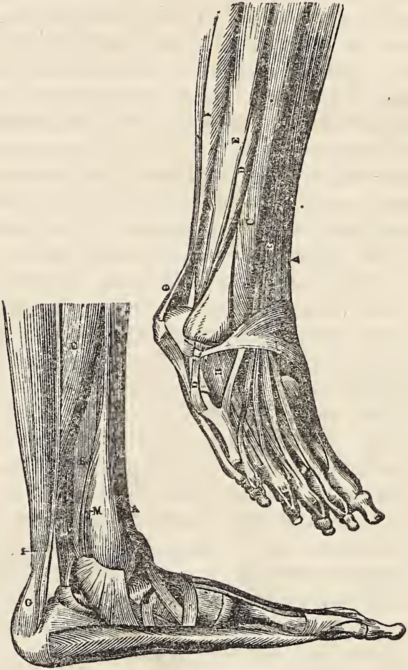
The strength of muscles seems almost incredible when we consider their size and the disadvantage at which they work. Turkish porters are said to carry burdens of five hundred pounds at a slow pace; ordinary porters often carry a mule load, or one hundred and fifty pounds. It has been estimated that the weakest man in health can lift one hundred pounds and a strong man four hundred. It is related of an Englishman named Topham, that he could lift eight hundred pounds with ease; that he could roll up a pewter dish by his fingers alone, and snap a hempen cord two inches around; he once bent a poker, an inch in diamter, around his neck and unbent it. He seems to have been a genius in this respect, and to have manifested nearly as much power of muscle as some men have of mind. That all this force is due to the presence of the life-power working through its organs as a medium, is proved by the fact that the same muscles which when alive could lift hundreds of pounds with ease, after death have been torn to pieces by the weight of a few pounds.

When we consider that the muscles producing these actions had so little chance of displaying their full power, we can hardly estimate the tremendous force Topham was capable of exerting, if all his entire energy was permitted to come into play. The smaller animals, that have but a few grains of matter in them, and so experience little or no inconvenience from the operation of gravity, and whose muscles are generally adapted to work to the greatest advantage, perform wonderful feats by their means, often leaping at a bound twenty times their height and a hundred times their length; and as in some of the beetles, able to move under a load three or four hundred times their weight.

The threads of tissue are variously arranged, according to the shape of the muscle and the offices it has to perform; some are long, filled with fibrin in the middle, and compressed into tendons at each end, giving the whole the appearance of a spindle ; some are fan-shaped, being disposed in rays converging toward the tendinous origin; others again are pennated, or disposed on each side of a long tendon, like the plumes on a quill. The muscles sometimes take their names from their shape, but more often from the bones they move or the actions they have to perform. Muscles are said to have their origin at the fixed point, and their insertion at the farther end, or that intended to be moved. The *extensors* are those that extend or straighten the limb ; the *flexors* those that flex or bend it. The supinators turn the palm of the hand in a supine or upward position ; the pronators turn the palm in a prone or downward position. A knowledge of the muscular system is very easy to acquire after the bones have been well studied.

Wherever irritation is present in any part of the body, blood will flow to that part, and a rapid increase in size results. On the contrary, a part lying at rest soon becomes almost useless. The Hindoo devotees, who vow not to use an arm or a leg, and in consequence keep either without active motion, soon induce paralysis of the particular parts. The student who spends most of his time in study, and uses his muscles but to walk to recitation, or move a pen, has them in a weak and flabby state. The same student, by taking proper exertion, can make them strong and vigorous, so that when contracted they will be as hard as bone. Exercise is absolutely necessary for the proper development of the muscular system, and for this purpose care must be taken to use every part, for exclusive attention to any one set of muscles is injurious to the others. Sailors accustomed to pull with great force the ropes of their vessel, and climb its shrouds, have their upper extremities large and powerful, but the lower ones often so weak as to easily tire by walking; on the other hand, noted walkers are seldom able to lift heavy weights. Those who have been neglectful in this respect, and wish to make up for past errors, should be careful at the beginning only to exercise a little, gradually increasing the amount performed until the full development is reached, the rule in all cases being to keep within the limits of fatigue. Walking by itself is not sufficient; the student should also saw wood, or do something of the same kind that would exercise the arms well; girls should practice calisthenics as well as walking. Whenever it is possible, let all this be done out of doors, that the free air of heaven may brace the system, and carry off its exhalations, and the sunbeams nerve it to greater strength and tone. Animals, like plants, if closely confined, become weak, pale, and sickly; and if we would enjoy our full powers, we must follow nature's plan, and observe her indications.

The flexors and extensors throughout the system antagonize each other's actions; the flexors have rather the most strength, which may be proved by the fact that when the body is in a state of complete repose, all its limbs are slightly bent. When a flexor contracts, it does not expand of itself, but is pulled straight by the extensor; and so in turn when an extensor contracts. If from any cause the tone of one set becomes weakened, its antagonists immediately draw the limb in their direction, for even in a state of apparent rest they are always pulling against each other. The part in this case remains permanently fixed in one position until relief is obtained. To cure such affections it is not only necessary to strengthen the weakened set by rest or other means, but in order to attain this object to repress the action of their opponents. Acting on this principle, surgeons have lately cured many cases of deformity that a few years ago were thought to be beyond hope. As an instance of this we will describe the operation for strabismus.



MUSCLES OF THE LEG AND FOOT.

A careful study of the bones and muscles which have been given thus fully in the book, will be of great assistance to the student in drawing.

A Tibialis Anticus—arises from the upper and outer part of the tibia; inserted into the inner os-cuneiforme, and the base of the metatarsal bone of the great toe. *Use*—to bend the foot.

B Extensor longus Digitorum Pedis—arises from the upper part of the tibia; inserted, by four tendons, into the bones of the four small toes. *Use*—extends the toes.

C Peroneus tertius—a portion of the last muscle, which arises from the middle of the fibula; inserted, by a tendon, into the root of the metatarsal bone of the little toe. *Use*—to assist in bending the foot.

D Peroneus Brevis—arises from above the middle of the outer part of the fibula, and, passing under the groove of the outer ankle, is inserted into the root and outer part of the metatarsal bone of the little toe.

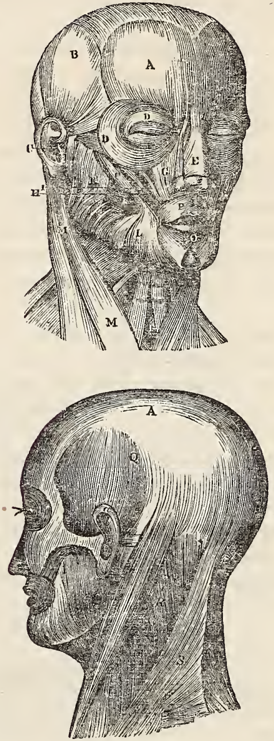
E Peroneus longus—arises from the upper and outer part of the peronea or fibula, and, passing through the channel of the outer ankle, turns under the foot, and is inserted into the root of the metatarsal bone of the great toe. *Use*—this, with the former, moves the foot outward, and extends it a little.

F Soleus (resembling in shape the sole fish) arises from the upper and back part of the tibia and fibula, and increases to a large fleshy belly, which lies under the gastrocnemius, and, terminating in a very strong tendon, which by some is called the tendon of Achilles, is inserted into the hinder part of the os calcis. *Use*—extends the foot. The action of this with the gastrocnemius and the flex. long. digitorum is very necessary in running, leaping, jumping, walking, and standing on tiptoe; and those who walk much, or carry heavy burdens, have these muscles larger than others.

K Flexor longus Digitorum—arises from the upper and inner part of the tibia, and is inserted into the last bones of all the toes, except the great toe. *Use*—to bend the toes.

L Flexor longus Pollicis—arises from the back part of the fibula, below its head; inserted into the last joint of the great toe. *Use*—to bend the great toe.

M Tibialis Posticus—arises from the back and upper part of the tibia and fibula, and is inserted into the os scaphoides, and partly into the under surface of the tarsal bones. *Use*—to move the foot inward, and to turn the toes inward.



MUSCLES OF THE HEAD AND NECK.

A Occipito Frontalis—arises from the occipital tuberosity; the tendon is expanded over the superior part of the cranium, and is inserted into the teguments of the forehead and eyebrows. *Use*—to move the skin, and raise the eyebrows.

B Attollens aurem, or Levator auris—arises from the tendon of the occipitis, and is inserted into the upper part of the ear, which is connected with the head. The action of this muscle is scarcely perceivable.

D ORBICULARIS PALPEBRARUM—surrounds the eyelids on the edge of the orbit, and is fixed to the transverse suture which crosses the nose from the corner of the eye. *Use*—shuts the eyelids.

F LEVATOR ANGULI ORIS—arises from the hollow of the superior maxillary bone, and is inserted into the corner of the mouth. *Use*—to raise the corner of the mouth.

G LEVATOR LABII SUPERIORIS ALÆQUE NASI—arises by two heads; one from the lower edge of the orbit, the other from the nasal process of the superior maxilla, and is inserted into the upper lip, and the outer part of the wing of the nose. *Use*—to raise the upper lip, and dilate the nostrils.

H ZYGOMATICUS MAJOR and MINOR—arise from the os malæ, near the zygomatic suture, and are inserted into the angle of the mouth and the orbicularis oris. *Use*—to raise the corners of the mouth, and to draw it outward.

K MASSETER (chewer) arises from the higher part of the upper jaw, and is inserted into the lower part of the under jaw. *Use*—to raise the jaw, and draw it obliquely outward.

L DEPRESSOR ANGULI ORIS—arises from the under part of the lower jaw, at the side of the chin, and is inserted into the angle of the mouth *Use*—to depress the corner of the mouth.

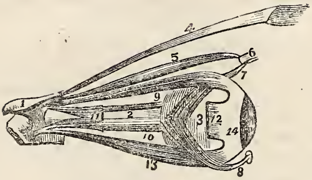
M MASTOIDEUS—arises, by two distinct origins, from the sternum and part of the clavicle, and is inserted into the mastoid process. *Use*—to turn the head to one side, and bend it forward.

O DEPRESSOR LABII INFERIORIS—arises from the inferior part of the lower jaw, next the chin; runs obliquely upward, and is inserted into half the edge of the under lip. *Use*—to depress the under lip.

P ORBICULARIS ORIS—formed by the insertion of the fibers of other muscles, and constitutes the principal part of the lips; it is inserted into its fellow at the angles of the mouth. *Use*—to shut the mouth.

R SPLENEUS, or SPLENII (resembling the spleen), arises from the three lower vertebræ of the neck, and the five upper ones of the back, and is inserted above the mastoid process. *Use*—to move the head backward and sideways.

T STERNO HYOIDEUS—arises from the sternum, the clavicle, and the cartilage of the first rib, and is inserted into the base of the os hyoides (a prominence in the fore part of the neck, situated behind and nearly upon a level with the base of the lower jaw). *Use*—to depress the os hyoides.



MUSCLES OF THE EYEBALL.

Fig. 1 represents the bony portion at the back of the orbit, from which all its muscles originate by tendons; 2, the optic nerve running into the eyeball; 3, the tendinous expansion of the external straight muscles, whose other extremities are seen at 11; 4 a, the muscle that elevates the eyebrow; 5, superior oblique muscle; 6, its pulley; 7, its tendon, after passing the pulley, running to be inserted into the eye; 8, inferior oblique muscle; 9, superior straight muscle; 10, internal straight muscle; 12, portion of the tendon of the external straight muscle; 13, the lower straight muscle.

The eyeball has six muscles, whose tendons are inserted into the sclerotic coat, and help give the outside of the ball its dense white appearance Of these four are straight, and two oblique; the superior oblique has its origin at the back of the orbit, and sends its tendon through a little pulley of gristle hanging from the roof of the orbit; it is then inserted like the rest in the sclerotic coat. Bell beautifully remarks, that there are two sets of muscles which govern the motion of the eyeball. Four straight muscles attached at cardinal points, by combining their action, move it in every direction required for vision, and these are subject to the will. "When the straight muscles, from weariness or exhaustion, cease to guide the eye, two others operate to roll it under the eyelid. So that in sleep, in fainting, and in approaching death, when the four voluntary muscles resign their action, and the retina is no longer able to receive impressions, the oblique muscles prevail, and the pupil is revolved so as only to expose the white of the eye. It is some consolation to reflect that what is considered the effect of agony is only apparent, and occasioned by the peculiar structure of our animal frame."

If the external straight muscle of the eyeball is weakened from any cause, the eye is at once turned toward the nose by the internal straight muscle, and remains thus fixed. To give the injured organ rest, and allow nature to strengthen it, the surgeon enters the cavity of the orbit by cutting the conjunctiva, and then passing a hook around the internal straight muscle, draws it toward him and completely divides it. The external muscle pulls the ball straight, the operation, which is a very simple one, and attended with little pain, is finished; the internal muscle is soon healed by the life-power connecting the divided ends by means of cellular tissue, and, if necessary, filling the cells with fibrin. Usually by the time this is over, the weakened muscle has regained its tone, and the cure is perfected.

There are muscles to move the scalp or covering skin of the head, and also others to move the ears; but from want of exercise they gradually lose their tone, and in civilized society are rarely seen capable of contraction. Buffoons, aware of this, carefully cultivate them by use, and are thus enabled to play many antics, to the surprise of their spectators, such as throwing their hats off without the aid of the hands, and flapping their ears as readily as many of the lower animals. Indians are said to possess these powers in a very high degree, and they are sometimes seen exhibited by schoolboys.

The body is so constituted as to assume an erect position, and this is the only one capable of longest endurance with the least fatigue. A man can walk, or hoe, or cut grain with a scythe much longer and with less strain in this posture than in any other. Persons who habitually stoop lose much of their muscular power unnecessarily by the increased exertion the muscles are forced to make to maintain such an unnatural position. In most cases it can easily be remedied by care in keeping the chest expanded, throwing the head backward, and balancing weights on the head while walking, in the same manner that the Indian women carry water pitchers on their heads, who thereby acquire such ease and erectness that travelers tell us they have an unequaled grace and majesty of deportment.

Some degree of attention is necessary to be paid to the muscles of the forearm in acquiring a rapid and easy style of penmanship. The entire weight should be thrown on the left arm. The desk should be slanting, and not higher than the elbow when reclined; the latter always pointing toward the body, and not from it, and the forearm touching the edge of the desk about midway between the elbow and wrist, to allow perfect freedom of motion. The manner of holding the pen is important, as it is the same as that adopted by the anatomist in using his knife and the painter his brush. The forefinger should lie easily upon the holder, the lower part of which is also supported and guided by the side of the end of the second finger. The two joints of the thumb should always stand out prominently, and its end touch the holder opposite the first joint of the forefinger from the nail. The third and fourth fingers rest on the table, and support the hand. The head of course should be held erect, and the trunk rather inclined forward. This posture will not only display the full force of the muscles, but also enable the writer to perform his work with far more celerity and less fatigue.

The muscles of the face by their workings give expression to the countenance; and as particular sets of them express particular feelings, it has long been a favorite employment with many persons to study the face, so as to receive from it an idea of the character, they supposing that certain sets of the muscles would be more or less developed, according to the trains of thought indulged by the individual who called them into play. John Bulwer, an English anatomist, published a book in 1649 on Physiognomy, or the study of character by the countenance, in which he proposed a new classification of the muscles, according to their actions; thus the muscles that shake the head he called the denying muscles, and those that pucker up the lips the kissing muscles. He gave a minute description of the cellular membrane that covers the face like a mask, underneath which work the forty-six muscles, and twenty-four of these being destined to assist the motions of the eyes and eyebrows alone, draws from this an argument to show the importance of these features in the physical language of the passions. He tells us that by means of these muscles man with his countenance can express his thoughts when it is inconvenient for him to do it in words.

An anecdote is told of a lady named Clairon, who sat in a chair before a numerous audience, and painted in succession upon her countenance the whole series of passions, with all their various shades and modifications; and upon being asked how she did it, replied that she had made a special study of anatomy, and thus knew what particular muscles to move in order to express certain passions of the mind. But this must have been false, as the combinations are so intricate, and the difference in shading often so slight of one emotion from another, that she could only have called them into play by successively rousing her passions, and nature would then do the painting without the aid of any information on anatomy.

Sir Charles Bell was the first who taught the doctrine, that the feelings of the mind first act upon the heart, and then, by means of the sympathy of the respiratory function, react, so as to produce what we call expression in the countenance. He tells us the man was wrong who found fault with nature for not placing a window before the heart, in order to render visible human thoughts and intentions, and that there is, in truth, provision made in the face and outward bearing for such discoveries. He fully endorses the opinion that every strong emotion is directed toward the heart; that this organ has many sensations, pleasant and unpleasant, over which it has no control, and from it the effects are diffused over the body. We will quote an instance of his mode of explaining this diffusion by means of respiration in the case of terror. "We can readily conceive," he says, "why a man stands with eyes intently fixed on the object of his fears, the eyebrows elevated to the utmost, and the eye largely uncovered; or why, with hesitating and bewildered steps, his eyes are rapidly and wildly in search of something. In this we perceive the direct influence of his mind upon the outward organ. But observe him further: there is a spasm on his breast, he can not breathe freely, the chest is elevated, the muscles of his neck and shoulders are in action, his breathing is short and rapid, there is a gasping and convulsive motion of his lips, a tremor on his hollow cheek, a gulping and catching of his throat; and why does his heart knock at his ribs, while yet there is no force of circulation, for his lips are ashy pale?" Bell points out the direct and indirect action of the passions, as just described, and shows us that it is the latter alone which men in such cases as grief will have obtruded upon them, and that the true actor, to preserve the dignity of his character, must study the latter, and only permit in his representations the uncontrollable signs of suffering to escape, which in themselves betray how much is felt and how much restrained.

Bell's criticism on the piece of sculpture called the Dying Gladiator is not only matchless in itself, but is besides very valuable, as showing the importance of a thorough knowledge of anatomy in the fine arts. "This," he says, "is one of the masterpieces of antiquity, which exhibits a knowledge of anatomy and man's nature. He is not resting, he is not falling, but in the position of one wounded in the chest, and seeking relief in that anxious and oppressed breathing which attends a mortal wound with loss of blood. He seeks support to his arms, not to rest them or to sustain the body, but to fix them that their action may be transferred to the chest, and thus assist the laboring respiration. The nature of his sufferings leads to this attitude. In a man expiring from loss of blood, as the vital stream flows the heart and lungs have the same painful feeling of want that is produced by an obstruction to the breathing. As the blood is draining from him, he pants and looks wild, and the chest heaves convulsively. And so the ancient artist has placed this statue in the position of one who suffers the extremity of difficult respiration. The fixed condition of the shoulders, as he sustains his sinking body, shows that the powerful muscles common to the ribs and arms have their action concentrated in the struggling chest. In the same way does a man afflicted with asthma rest his hands or his elbows upon a table, stooping forward, that the shoulders may become fixed points. The muscles of the arm and shoulder then act as muscles of respiration, and aid in the motion of the chest during the heaving and anxiety which belong to the disease."

A story is told of a celebrated painter whose king admired very much in one of his pictures a child in the act of crying. "Has your majesty," said the painter, "a mind to see how easy it is to make this very child laugh?" The king assented; and the artist, by merely depressing the corner of the lips and inner extremity of the eyebrows, which were raised before, made the little urchin, which at first seemed breaking its heart with weeping, equally in danger of bursting its sides with laughter; after which, with the same ease, he restored the former expression.

CHAPTER VIII.

THE NERVOUS SYSTEM.

Uses of the Electric Telegraph—Nervous Telegraph governing Nutrition—Special Agents of Secretion—Performance of Organs when highly Excited—Different Meanings of the Word Nervous—Two Systems of Nerves—Anatomy and Physiology of the Ganglionic System—Ganglionic System not Sensitive—Power of the Passions—Bell's Theory of Expression—Sympathy—Operation of Medicines—Nervous Systems of the Various Classes of Animals—Anatomy of Nervous System of Animal Life—Development of Nerves—Case from Cooper—Anatomy of Spinal Cord—Office and Ganglia of the Spinal Marrow—Story from Descartes—Disease of the Membranes of the Spinal Marrow—Anatomy of Cerebro-Spinal Axis.

In former times, when an empire or kingdom enlarged its boundaries to any great extent, and more especially if it was composed of diverse nations, it had a sure downfall and became separated into its original states. This happened from the want of a common bond of union and rapid means of communication ; and it is evident that every complicated system, whether political or mechanical, requires such means to hold the parts together. On this account the discovery of the electric telegraph was hailed with joy by those true friends of the Union who had previously been witnessing the growth of our country with alarm. They saw at once that it was possible, by means of this agent, and our railroads, to control and oversee even the whole of North America, with more speed and certainty than the small area of a petty kingdom in former times, with the powers at command of their rulers. What the electric telegraph is to a nation, the nerves are to the human body, supervising the various organs, and directing the performance of their different offices in complete harmony with each other, and with the whole system.

When food is taken into the mouth the nervous telegraph sends the news to its center, from whence orders are transmitted to the salivary glands to pour out saliva; to the esophagus to swallow the morsel; to the villous coat to pour out gastric juice; to the stomach to contract and pass the chyme into the duodenum; to the liver and pancreas to pour out their secretions; to the lacteals to take up the chyme and convey it to the mesenteric glands and thence to the thoracic duct. As each stage of the process is completed, information is carried to the nervous center, from whence directions are sent to the proper agents for carrying on the next stage, so that every successive act is performed at the right time and place, from insalivation to the working of the secernents in the capillaries. A single morsel sets in operation a wonderful machinery, every motion of which is executed with unerring precision. The office taken by the nerves is shown by the fact that when one of them leading to a part is cut, the organ it connected, being then isolated, is unable to perform its functions.

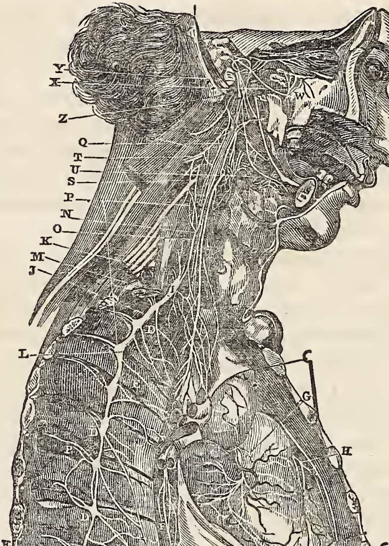
The special agents stationed in various portions of the body to assist in the organic movements are, like the life-power of which they form a part, immaterial, and therefore forced to use a medium of communication with matter; this medium is a secretion. Thus there is a special agent to form chyme, but it can not act on the atoms of food until the gastric juice is poured out; it then permeates this fluid, and by its means comes in contact with the particles taken into the stomach, forcing them to obey its power and combine in such a manner as to make the compound atoms required. It is this minute study of phenomena that leads us more clearly to perceive the difference between the vital principle and the chemical and mechanical forces, for the special agent acts just in proportion to the force of the command sent from the nervous center. Sometimes, as in dyspepsia, the agent is so feebly impressed that it works with little energy, allowing many of the atoms to escape its power, and the ever-present chemical laws serve the chance of combining, and thus great quantities of gas are generated, whose pressure produces much pain and distension. Imperfect chyme is the result, and this, fortunately, is not permitted by the sentinel at the pyloric orifice to pass into the duodenum, and it remains in the stomach to be recombined. Life is a forced state, and wherever intense stimulation ceases, disturbance in consequence of the triumph of the Pullers-down at once ensues.

What an organ is capable of performing, under a high degree of excitement, is seen in the case of muscles. Isaac Taylor, in speaking of the apparatus for the concentration of mobility, truly says, "That the muscular force is truly felt to be a *restrained* power; a faculty equal to much more than is permitted to it; and, perhaps, with not a few, the conscious mechanical energy is strictly analogous to that of a strong man, fettered and handcuffed, who meditates what he will do when set at large." Great muscular power is rarely accompanied by much mental energy; but when both are combined, the most astonishing effects are produced. The madman, whose muscles are soft and flabby, and his frame small, will, in a paroxysm, often display the strength of a dozen men. The ancients symbolized Hercules, who was a kind of traditionary Sampson, with an enormous bony and muscular system and small head; Jupiter, with a comparatively small frame and very large head.

In former times anatomists gave the name of nerves to all the white cords they found in the body, supposing them to belong to muscles and their size to indicate power, they termed one gifted in this respect a nervous man. It was afterward discovered that one set only of these cords (tendons) was attached to muscles, the other set, for which the old name was retained, being connected with the brain. Hence two opposite meanings have arisen for the word nervous: one to indicate strength and power, the other weakness and irritability; to express the former meaning, tendinous is the appropriate term.

Like tendons, the nerves are made up of long threads of cells, but, unlike them, are filled with albuminous matter. Every nerve, or bundle of nerves, has its own sheath to separate it from other organs, and wherever it lies in parts exposed to motion, it is arranged in a spiral form, to allow for the necessary lengthening and shortening without injury to its inelastic tissue. The sheaths of nerves coming from the brain are continuous with the dura mater (hard mother), and this circumstance probably gave the lining membrane its name. There are two kinds of nervous substance, the white and the gray. The common nerves are white, and when traced to their centers, always end in a mass, more or less large, of gray matter; this latter is called a ganglion (knot), and supposed to be the seat of power and influence, as the nerves are merely media of communication.

There is a special nervous system for the purpose of superintending the secretions and nutritive apparatus; and another one for the intelligence to govern the voluntary muscles. The first is called, from the number of knots in it, the ganglionic system of vegetable life, and the other, the nervous system of animal life. Both systems connect in various places, by means of a close intermingling of meshes of nervous threads, called plexuses. The vegetable system has its first ganglion in the orbit of the eye, and its last at the lower part of the sacrum.



GANGLIONIC SYSTEM OF VEGETABLE LIFE.

This beautiful engraving is a miniature from the grand plate of

Manec; it presents a view of most of the structures of the system in their relative position, and clearly shows the nervous connection and central ganglia. A careful study of it, by means of the description, will be both interesting and instructive.

A A A A semicircular ganglion and solar plexus; situated just below the diaphragm and behind the stomach; blows on the latter organ have produced instant death, by injuring this nervous mass. The semilunar ganglion is the great center or brain of the system of vegetable life; and its intimate connection with the stomach explains the sympathy of that organ with all disturbances in the body. From this fact Hunter termed the stomach the "center of sympathies."

B small splanchnic, or visceral, nerve, which sends its branches to the organs (viscera) of the abdomen; it is formed by two or three twigs furnished by the last ganglia of the chest. C great splanchnic nerve; larger than the former, and branching downward for the same purpose as the other; it is formed by the union of from four to eight twigs coming from as many ganglia of the chest.

D D D thoracic, or chest, ganglia; ten or eleven in number, lying on the heads of the ribs or spaces between them; of course situated near the spine; E internal branches, lying on the bodies of the vertebræ, and connecting with each other to advance toward the front of the body, where they become distributed over the esophagus and the aorta; F external branches; two for each ganglion, differing from each other—one large, reddish, and pulpy, joining the intercostal, or sympathetic, nerve; the other of the usual whiteness, small, giving off no twigs, and passing to the ganglia, seemingly intended for mere communication.

G right coronary plexus; passing between the pulmonary artery and the aorta to accompany the front coronary artery.

H left coronary plexus; passing before the left branch of the pulmonary artery to go to the back of the heart, and accompany the left coronary artery.

I inferior cervical (neck) ganglion; it is placed behind the vertebral artery; J inferior twigs, generally but a single branch, connecting with the first chest ganglion; K external threads, very slender, connecting with the last ganglion of the neck and two of the back, and sending minute threads to pass around the subclavian artery; L internal twigs, very minute, and distributed to the *longus colli* (muscle which moves the neck on one side)—some of the branches descend to the pulmonary plexus; M anterior threads, few in number, forming the lower cardiac nerves.

N middle cervical ganglion; placed on a level with the sixth vertebra of the neck, and covered by the internal jugular vein; O interior twigs, three or five in number, passing over the inferior cervical ganglion; P external twigs, varying in number, and giving off branches connecting with the cervical pairs and phrenic nerve.

Q superior cervical ganglion, situated on the front and side of the second, third, and fourth vertebra of the neck; R superior branches, two in number, and placed behind the internal carotid artery; S inferior branch, sometimes double, and descending upon the great straight muscle as far as the middle cervical ganglion; T external branches, varying in number, and connecting with the first, second, and third cervical pair.

U submaxillary ganglion, placed on the inner side of the submaxillary gland.

V videan nerve, springing from the back part of the spheno-palatine ganglion; W naso-palatine branch of the same ganglion, whose center is shown at X.

Y opthalmic ganglion, lying in the orbit of the eye outside of the optic nerve.

Z auditory nerve and membrane of the tympanum, containing in the same cavity the four small bones that pertain to the apparatus of hearing.

1 Renal plexus, belonging to the kidneys, and made up of threads coming from the solar and cœliac plexuses, from the last ganglion of the back, from the first one of the loins, and from the small splanchnic nerve.

2 2 Lumbar (loins) ganglia, five in number, and each one corresponding to a lumbar vertebra; 3 internal branches, very numerous, and going down to the aorta, where they join in the aortic plexus; 4 external branches, two arising from each ganglion; they follow a winding course to connect with the front branches of the lumbar nerves.

3 Aortic plexus; formed by threads from the solar plexus, superior mesenteric, renal, and small splanchnic nerves, and internal branches of the lumbar ganglia.

The ganglia in general are of a small oval shape; that of the plexuses vary according to arrangement of the meshes, but always very irregular. This description not only shows the importance of the nervous system, but also the exceeding care nature has taken to send its branches to every organ, no matter how minute—so that all are connected in one harmonious whole.

In a healthy state, the ganglionic system manifests no sensibility, and for any organ it controls to give signs of feeling shows a morbid condition; hence Dr. Johnson's remark, that we may be sure something is going wrong whenever we are aware either by pleasant or painful sensations referable to that organ that we have a stomach. In surgical operations, the painful part is mostly over after the skin has been cut. Hervey, when studying the circulatory system, became acquainted with a young nobleman in London whose left side, in consequence of disease, had become unable to protect the heart, which, in consequence, might be seen and handled, and its contractions and expansions easily witnessed. When care was taken not to touch the surrounding parts when handling it, the gentleman was wholly unconscious whenever it was grasped.

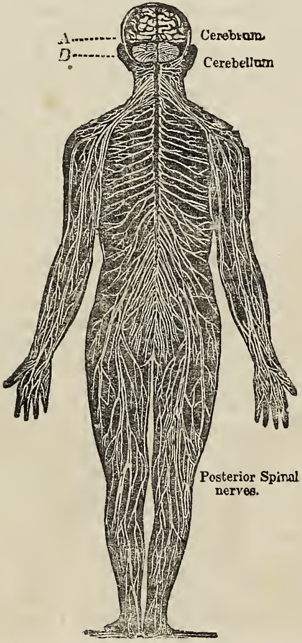
Although the will has no power over the organs of vegetable life, yet the passions influence them to a great degree. On this fact Sir Charles Bell laid the foundation of his theory of expression, wherein he describes the passions as acting first upon the heart, which in turn reacting upon the respiratory system induced the changes of the countenance. So powerfully do the passions affect this system of vegetable life, that sometimes they have entirely stopped its working; thus numerous cases are known where fear and joy have each been fatal. The doorkeeper of Congress fell dead after hearing the news of a great victory of the American arms. Criminals have died at the bar the moment after sentence of death was pronounced against them. The minor influences of the passions are felt in every-day life to a greater or less degree. Bad news will take away the appetite of a hungry man, and the fear of drowning has often cured sea-sickness. The same kind of effects are observed in the lower animals. The bite of an angry dog has caused hydrophobia, when the same injury an hour afterward on another proved harmless.

Sympathy is that property of the nervous system by which it exactly daguerreotypes the condition of one part on the rest. An impression, for instance, is made on the excitability of the stomach by alcohol; the exact copy of the peculiar state induced is carried to the nervous center, which it impresses in the same way, and from this center there is radiated to every part the morbid condition. It is probable that the nervous matter secretes a special fluid to enable it to carry on its functions, and that it is owing to alterations of this that the sympathetic changes occur.

Medicines operate by acting first on the excitability of the part they touch, and the resulting sympathetic action explains all the succeeding phenomena. Croton oil will powerfully move the intestines when merely placed upon the tongue. A small quantity of prussic acid has caused death by being dropped upon the naked arm, and mercurial ointment has salivated when rubbed on the hand or leg. It is an erroneous notion that medicines act by mixing with the blood and freeing it from all impurity. It would be a hard matter for them to gain admission into the channels of the circulation by bribing the various sentinels through the long and tortuous path that conducts to the veins; and once entered every energy of the system would be promptly called into play to eject the unwelcome intruders.

The possession of a nervous system, as before mentioned, is an attribute of animal life, and closely and clearly defines the distinction between both kingdoms. The lowest animals—as the *Radiated*, among which are the sponges and starfish—have but two ganglia, those of motion and sensation; these are generally placed in the form of a double ring about their mouths, with nervous filaments radiating on all sides. As we ascend the scale, we find in the *Articulated*, as worms and insects, the ganglia of the special senses added, the ganglia of motion and sensation being arranged in the form of knots, connected by lines of nervous cords and those of the special senses situated above the mouth; the jointed appearance of such animals gives them their name. The *Mollusca*, or soft-bodied animals, as the oyster and snail, have a still more complicated apparatus; and we come finally to the *Vertebrated*

—those having a back bone—which, possessing all the ganglia of the inferior classes, have an additional one which, as the animal rises in intelligence, becomes more and more developed, covering all the others, and causing the necessity of a skull to contain it. This last ganglion is supposed by anatomists to be the instrument of the understanding in the lower animals, as in man, and to be the medium through which the powers they have in common exhibit themselves; not that they presume any identity in the nature of both from this circumstance, but that the same kind of apparatus is mainly used to produce the same effects.



NERVOUS SYSTEM OF ANIMAL LIFE.

The ganglions of animal life are protected by a bony envelope through orifices in which run the nerves connecting them with the body. In the description we will commence with the lowest ganglia, those of motion and sensation, and proceed upward.

There are thirty-one pair of spinal nerves, divided as follows, from their location: eight pair for the neck, called cervical; twelve pair for the back, called dorsal; five pair for the loins, called lumbar; and six pair for the back of the pelvis, called sacral.

Cervical Nerves, eight pair: the first pair is called *occipital*, and is sent around the occiput to the neck; the second pair supplies the salivary gland and external ear; the third pair supplies the skin and muscles of the shoulder, and sends a branch to combine with others to form the nerve of the diaphragm; the fourth, fifth, sixth, seventh, and eighth pair unite to form the brachial, or arm, plexus, from which arise the six following nerves: the *axillary* nerve, running round the neck of the humerus in the armpit (axilla), and ramifying in the muscles of the scapula; the *external cutaneal*, which, sending branches in its downward course, terminates in the skin of the hand; the *internal cutaneal*, dividing in two parts—one for the palm of the hand and the other for the little finger; the *median nerve*, which sends branches to the muscles of the hand, thumb, fore and middle fingers; the *ulnar nerve*, supplying the ring and little fingers and the muscles of the hand; the *radial nerve*, supplying the muscles of the lower part of the hand and arm.

Dorsal Nerves, twelve pair; the first pair gives off a branch to the brachial plexus; most of the dorsal nerves are distributed to the muscles of the back and ribs; the five inferior pair go to the cartilages of the ribs, and are called *costal*.

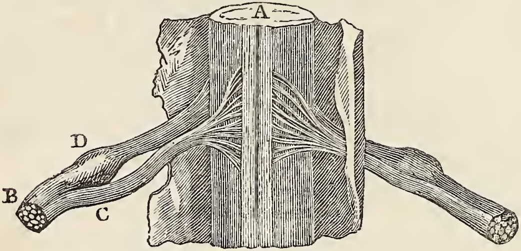
Lumbar Nerves, five pair; principally bestowed about the skin and muscles of the lumbar region; some branches, from the second, third, and fourth pair, unite and form the *crural nerve*, which runs down the leg, sending off branches as it descends to the skin and muscles until it ends in the skin of the great toe; the fifth pair is joined to the first pair of sacral nerves.

Sacral Nerves, six pair; these form by their union a mesh resembling a horse's tail, and are hence called *cauda equina;* the first four pair give off branches to the organs in the pelvis, and then unite with the last lumbar nerve, to form a large plexus, which gives off the *ischiatic* nerve, the largest in the body, which, as it descends, sends many branches to the surrounding parts; after it passes the ham it is called the *popliteal* (ham) nerve; this continues to send off twigs until it divides in two parts: the peroneal (from *perone*, the fibula), which runs down the fibula, or small bone of the leg, and distributes threads to the muscles of the leg and back of the foot; the *tibial*, which, after running through a large muscle of the tibia, enters a notch in the os calcis and goes to the sole of the foot, where it terminates in the external and internal plantar nerves, to supply the muscles and tissue of the foot and toes.

In describing the nerves, we have spoken of them in the usual manner, as running downward from trunks and centers to the different parts. This plan, although the most convenient for explanation, is exactly opposite to the real fact; for they are first perfected at the extremities and then proceed to their ganglions, uniting in trunks with others they happen to meet, and thus forming trunks and plexuses. The separate threads, however, do not join, but remain apart, fulfilling their peculiar offices, one of them never being able to carry on the function of another. Thus the nerves of sensation and motion are so intimately intermingled at the extremities, that they can not be distinguished from each other, yet cases have often occurred in which all feeling was lost, while the power of voluntary motion remained perfect, and on the other hand motion remained while feeling was entirely gone.

Sir Astley Cooper cites a case of a man who was completely deprived of the faculty of sensation in one hand and arm, the muscular power of which was however preserved. When this man was desired to lay hold of any thing and lift it, he did so very well, and held it as long as his attention was closely fixed upon the object; but if his mind was called to something else, the limb would begin shaking and the article would soon fall to the ground. The necessity of sensation is seen from this fact, for the mind must be kept constantly informed about the grasp of the muscles, so that their energy may be excited whenever they begin to weary. A man who had lost the power of feeling in his leg was directed by his physician to bathe it in moderately warm water; it was brought in the room boiling hot at a time when the patient was absent; he entered very soon after, and as soon as he saw it at once immersed his leg; being alone he was not aware of its temperature until he found by sight that he had severely blistered the limb. Instances of paralysis might be mentioned in which, while sensation was even more than usually acute, there was a total incapacity of motion.

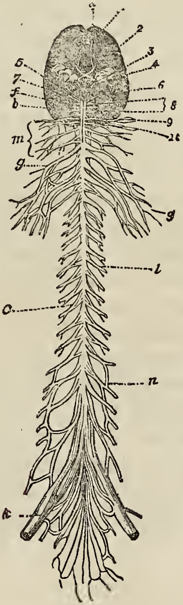
The nerves of sensation and motion are bound in the same sheath after they leave the extremities, and run together until within a short distance of the spinal cord, at which point they separate that each may enter its own ganglion. It is supposed by some that each nerve is double, one of the threads being intended to carry news to the brain, and the other to convey orders from it.



SPINAL CORD AND NERVES.

A represents the spinal cord, which, from the sacrum to the neck, has but two ganglia, or masses of gray matter; B shows the united nerves enveloped in a common sheath, and gives a correct view of the threads which make up the trunk; C shows the branch for motion entering the front portion of the spinal marrow; D the branch for sensation, which has a knot formed in its substance by its threads rolling up into a ball after leaving the motor twig, the mass of threads then running into the back portion of the spinal marrow. Sir Charles Bell divided the motor branch in several of the inferior animals, and the parts it connected were at once deprived of voluntary motion; upon cutting the sensitive branch all signs of feeling vanished; it was by such cruel experiments he demonstrated the truth of his theory.

It is now a well-established fact in medical science that the spinal marrow may be regarded, as far as feeling and voluntary motion are concerned, as the sole medium of communication between the brain and the external world, its two front columns being the ganglia of motion and its two back columns the ganglia of sensation. Sir Charles Bell added a third ganglion, in the vertebræ of the neck, intended, as he tried to prove, for respiration; but this has not been admitted, as physiologists have doubted the conclusiveness of his arguments for this purpose.



CEREBRO-SPINAL AXIS.

This engraving shows the front portion of the spinal marrow and the base of the brain, together with the trunks of the nerves running into them. The spinal marrow must be imagined as continued upward, having the ganglions of the special senses successively added, until it finally terminates in the great hemi-spherical ganglion, or instrument of intelligence.

a shows the cerebrum, or large brain; *b* the cerebellum, or little brain, lying back of, and under, the former; the letters *m g i* show the cervical, dorsal, and lumbar nerves; *k* the ischiatic nerve; 1 shows the nerves of smell; 2 those of sight, etc. These will be referred to and described afterward, and are here only introduced to show a connected view of the system.

Consciousness, by a law of the organism, refers all the impressions made by a nervous thread to the particular part where that nerve terminates in the extremities, so that if by some means irritation is produced on any part of it, the effect on consciousness is the same as if the end alone were acted upon. Descartes tells of a child who, with his eyes bandaged, had lost several of his fingers by amputation, and yet continued to complain for many days successively of pains, now in his joints, and now in that of the very fingers which had been cut off. His study of this led him to form a new system of mental philosophy. In a hospital, some years since, a leg was cut off just above the knee, yet whenever the stump became irritated pains were felt which consciousness referred directly to the foot and toes. In the same manner disease of the membranes of the spinal marrow will cause the most agonizing sensations of pain, apparently proceeding from injuries inflicted on the various portions of the body to which the nerves connecting with the spine are distributed. The physician in such cases uses remedies to act on the spine alone, without attending to the apparent seats of the pain.

CHAPTER IX.

THE NERVOUS SYSTEM CONTINUED.

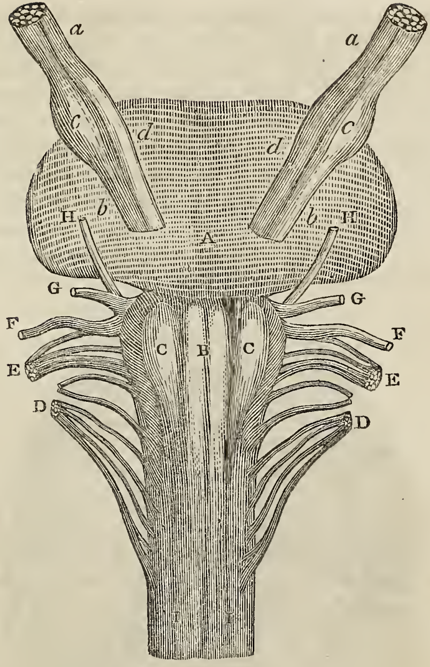
Names given by the Older Anatomists—Evolution of the Human Brain—Size the Measure of Power—Anatomy of Medulla Oblongata—Twelve Pair of Cranial Nerves—Anatomy of Base of the Brain—Sense of Taste—Nerves of Smell and their Function—Optic Nerves and their Function—Anatomy of the Eye—Restoration of Sight—Third and Fourth Pair of Nerves—Anatomy of Nerves of the Brain—Sixth Pair of Nerves—Anatomy of the Ear—Eighth and Ninth Pair of Nerves—Sense of Taste—Tenth, Eleventh, and Twelfth Pair of Nerves—Intercostal Nerve—Anatomy of Lower Surface of the Brain—Anatomy of Corpus Callosum—Anatomy of Upper Part of the Brain—Secretion of Nervous Fluid—Hygiene of the Brain—Necessity of Sleep—A Sound Mind requires a Healthy Body—Mental Philosophy—Views of Dr. Wigans on Insanity—Thinking with one Side of the Brain—Phrenology—Anatomy of the Ganglia—Views of the Older Philosophers.

The older anatomists, who examined the brain, knew very little of its true offices, and hence gave names to the various parts they saw in it, sometimes from a fancied resemblance to other bodies, but most generally for the mere purpose of distinguishing one portion from another. Unfortunately their terms have been retained by the moderns, who have thus entailed a double labor on the students: first, to master the names, and secondly, the functions, to which the names have no reference. At the upper portion of the spinal marrow successive rows of ganglia are placed, as before mentioned, until we arrive at the last, or instrument of intelligence. It is a curious fact that above the neck the fibers cross each other and pass over to the opposite side; the organs of animal life being double, we have two brains as well as two feet and two hands; the right brain, in consequence of the crossing of the fibers, governs the left side, and the left brain the right side; this is a fact admitted by all, and proved by instances enough to place it beyond doubt. In paralysis of the left side of the body the right brain is diseased, and in paralysis of the right side the left brain is likewise always found to be the part affected.

It is now received as a settled principle by physiologists, that the brain of the human embryo becomes gradually developed; in other words, that the brain of the very young child is not the miniature brain of the full-grown adult. In its first stages it resembles that of fishes, next that of reptiles, next of birds, next of the lower mammalia as rabbits, next of horses, and so proceeds until after passing the orang-outang it is perfected in the human type.

The size of each ganglion shows the power of the nervous function that belongs to it; thus the optic ganglia are very large in birds whose sight is extraordinarily acute; the olfactory ganglion is large in those animals that hunt their prey by scent; and the auditory large in those noted for hearing. In describing the lower part of the brain it is enough to point out the origin of the nerves, and mention their destination, as that will include the offices of their ganglia.

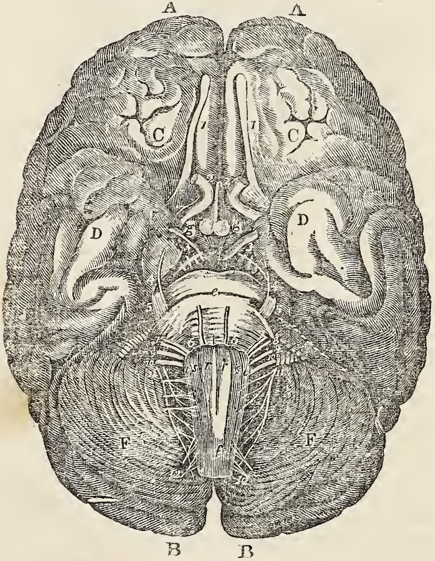
The following engraving shows the medulla oblongata M, or continuation of the spinal marrow, which is reducible into three pair of columns. A is the pons variolii, or bridge of Variolus, its discoverer; it is so called because its fibers cross each to form a connection between the spinal marrow and the upper ganglions of the nervous system, as the small and large brains, and centers of the special senses. B is the pyramidal body, some of whose fibers cross, and some run straight upward; it is named from its shape; C is the olive-shaped body; D the spinal accessory nerve; E the par vagum; F glosso-pharyngeal nerve; G portia dura, or the eighth; H fourth nerve; I anterior, or front column



MEDULLA OBLONGATA.

of the spinal cord; *a* fifth nerve; *b* ganglionic branch of the fifth nerve; *c* its ganglion; *d* its motor branch. It may be observed, from its form, that the fifth nerve is precisely shaped like the other spinal nerves.

Twelve pair of nerves connect with their ganglia inside the brain, including those of four of the special senses, taste, smell, hearing, and sight. The nerves that give the sense of touch come from the spinal marrow, and have already been mentioned. Buffon, and many of the older physiologists, consider touch to be superior to all the other senses; but this opinion is evidently erroneous, for although it gives aid to many of the others, it also receives aid from them. Tact is the sensation induced by the mere contact of bodies, as for instance the feelings of heat and cold; touch is the name given to a more particular examination, as when the fingers are passed over its surface. Like the other senses, touch is capable of being educated to a high degree of perfection, and much attention is paid to it in training the blind. Some cases are known in which those deprived of sight have been enabled by touch alone to distinguish colors.



VIEW OF THE BASE OF THE BRAIN.

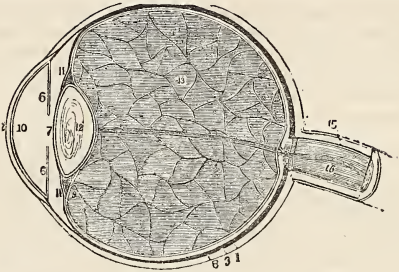
A A are the right hemispheres of the large brain; B B the left hemispheres; C C the front lobes of the right hemispheres; D D the middle lobes; E E the cerebellum, or little brain; *e* the pons variolii, connecting the two sides of the cerebellum; *f* the medulla oblongata, composed of three bodies of nervous matter *r s t*. The numbers refer to the names of the pairs of nerves that come from the base of the brain. The various little bodies seen are ganglions, from which the nerves take their origin.

The first pair, or the olfactory, arise from three distinct places; they unite and form a mass, which gives off great numbers of little threads, that pass through a sieve-like plate of the ethmoid bone, to be finally expanded upon the surface of spongy bones, situated in the upper part of the nose, and on the mucous membrane of that organ. The minute particles, or effluvium, thrown off from odorous bodies coming in contact with this nerve, produce the sensation of smell.

This sense may be educated until it attains a surprising degree of power and discrimination; perfumers can tell, by the smell alone, the various essences that enter into a compound, and, in many instances, their proportions.

The second pair, or optic nerves, pass each through the opening made for them in the sphenoid bone and become expanded on the inside of the eyeball. The vibrations of light act upon them in such a manner as to produce sensations of sight. The mechanism of the eye is exceedingly beautiful and well worthy of careful study. All the special senses are apparatuses of condensation to make impressions on their respective nerves sufficiently powerful to produce the requisite effects upon their ganglions, that the several sensations may be recognized by consciousness.

The engraving represents a section of the globe of the eye, showing its three coats, three humors, iris, cornea, artery, and the entrance of the optic nerve. Fig. 1 shows the SCLEROTIC (hard) coat, made up of dense, strong membrane, tightly investing and containing the interior parts and keeping the eye in shape; it is of a brilliant white luster, and is known commonly as the *white of the eye*. A part of the choroid coat is removed in front and its edges leveled to allow for the fixing in of a transparent thick membrane called the CORNEA 2; this answers

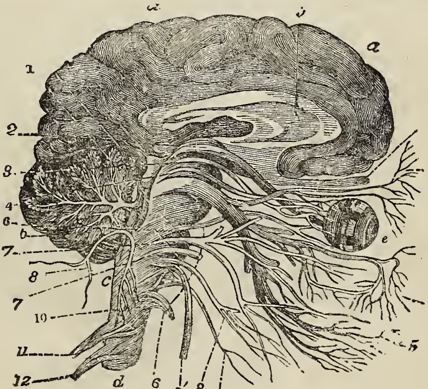


SECTION OF THE GLOBE OF THE EYE.

the same purpose and is set in the same way, and is of nearly the same form as the glass of a watch. If by disease the layers of this coat fail to transmit light, blindness is the result. Dr. Plouvier, of Lille, latterly made a curious experiment to remedy a defect of this kind in one of the lower animals. He states that he had a rabbit which was blind, but to whose eye he applied the cornea of another rabbit, and that the hitherto blind animal now sees perfectly. The CHOROID coat 3 lies immediately next the sclerotic; it is made up of a tissue of blood-vessels and secretes a black matter for collecting and absorbing all the rays of light that enter the eye; the eyes of rabbits and other animals in which this filament is not secreted present a red appearance internally, as the blood-vessels alone show in such cases. The RETINA 8 is the expansion of the optic nerve enveloped in a fine sheet of tissue. The IRIS is the colored circular curtain of the eye 6 6, whose contraction and expansion finely limit the quantity of light permitted to enter; its opening through which the light passes is called the pupil 7; the painting of this curtain, which adds so much to the beauty of the countenance, is another proof of the care taken by Providence to gratify our faculty of the beautiful; 10 11 11 are the chambers of the eye that contain the aqueous humor; 12 the crystalline lens; 13 the VITREOUS, or glassy, humor; the aqueous humor is replaced when allowed to escape, as is also that of the crystalline lens, but the vitreous humor is never renewed if let out. Cataract is a disease of the crystalline lens, by which it becomes clouded and nearly or quite obstructs the vision; to cure this the surgeon introduces a sharp instrument into the eye and cuts it up or removes as much as he can of it; if the operation is successful the absorbents remove whatever is left, and the life-power secretes a new capsule and fills it with liquid; and as the aqueous humor is also restored the sight is as good as before; 15 the optic nerve;

16 the central artery of the eye to nourish all its parts. It was by studying the construction of the eye, and imitating the different densities of its humors, that Dollond succeeded in making an achromatic telescope. The eyeball is inclosed in a bony socket, or orbit, which insures it full power of motion and the necessary protection from injury. The eyebrows help to shade it from light and prevent the moisture of the forehead running down on its surface, The eyelids are always ready to close and shield it from danger. Across its surface constantly flows a fluid from the lachrymal gland to free its external surface from dust and other impurities; this watery matter is prevented from running off the edges of the lids by a series of oil glands at their borders, whose secretion repels it, until after washing the eye it is carried through a duct hollowed out of the bone into the nose. So perfect is every part of the apparatus of vision that nothing more can be desired.

The third pair, or movers of the eye muscles, come from the motor ganglion of the spinal cord just after it has left the pons variolii; each nerve passes through a fissure in the sphenoid bone, and then supplies five of the muscles of the eyeball with filament for motion.



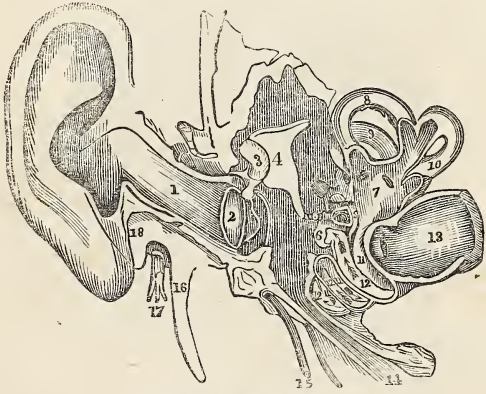
NERVES OF THE BRAIN.

This engraving gives a fine view of the relative position of the medulla oblongata, cerebellum, and cerebrum; the tree-like, branchy appearance of the cerebellum is well shown. The numbers refer to the nerves of the same name as we are now describing.

The fourth pair, or pulley nerves—sometimes known as the pathetic, from their office—passes out by means of a fissure on each side of the sphenoid bone, and are entirely distributed to the superior oblique muscles for moving them.

The fifth pair is divided into three portions, whose filaments endow the parts they run to with both sensation and motion; they escape from the brain by three separate openings. The ophthalmic branch sends threads to the forehead, eye, and nose; the superior maxillary branch to the teeth of the upper jaw and muscles of the face; the inferior maxillary branch to the teeth of the lower jaw, the surrounding muscles, and the ear.

The sixth pair, or motor nerves, each passing through a fissure in the sphenoid bone, go to the external straight muscle of the eyeball.



APPARATUS OF HEARING.

This engraving gives a view of all the parts of the ear. Fig. 1 the tube or passage that leads to the internal ear; 2 the drum of the ear; 3 4 5 the bones of the ear; 7 the vestibule, or central part of the labyrinth; 8 9 10 the semicircular canals; 11 12 the channels of the cochlea; 13 the auditory nerve, or portio mollis; 14 the channel from the middle ear to the throat. The outer ear is so shaped as to concentrate all the vibrations of air that fall upon it, bring them to a focus, and direct them to the internal ear, which conducts them to the tympanum, by which they are transmitted through the chain of four little bones to the inner cavities to act upon the auditory nerve. The air is allowed to escape from the internal cavities by the Eustachian tube, which permits its passage to the throat—otherwise, being pent up, it could not vibrate; this last opening is for a similar object to that made in the side of drums. Insects are prevented entering the ear by a bristling fence of strong hairs and an acrid, waxy matter purposely secreted. There is much dispute among physiologists relative to the offices of each part, and but little is really known about the matter. It is probable that the use of two ears is to enable us to tell the direction of sounds; for when one ear is shut, perfectly, in a dark place, so that the eye can give no help, it is impossible to discover from the sensation produced in what point sound proceeds.

The seventh pair (portio mollis, soft branch) enters the hard structure of the temporal bone and is expanded upon the internal apparatus of hearing; the nerve at this portion is surrounded by a watery matter, so as to catch, as it were, all the vibrations.

The eighth pair, or portio dura (hard branch), comes from the upper portion of the medulla oblongata; each passes out by means of an opening below the ear, and is distributed to the muscles of the face and of the external ear. It is a motor nerve to the muscles that give expression to the face.

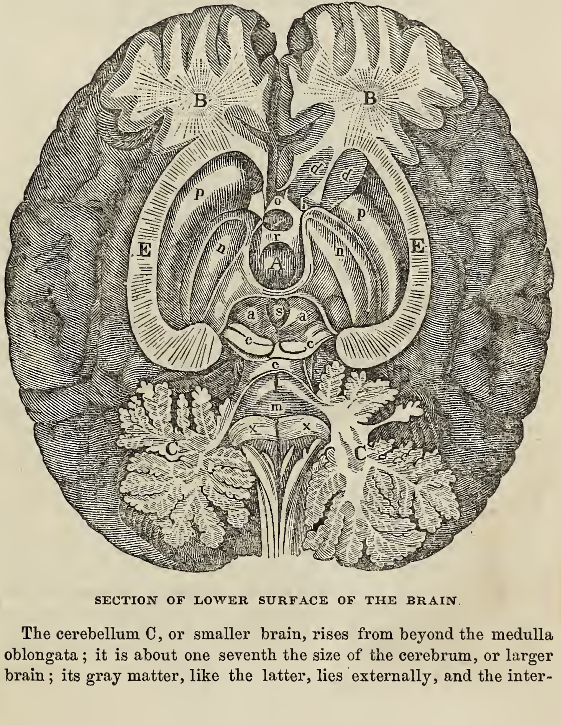
The ninth pair, or glosso-pharyngeal (belonging to the tongue and pharynx), arise near the olivary bodies, and are distributed to the pharynx and mucous membrane at the back of the tongue. These nerves are sensitive, and at one time were supposed to be the ones that conveyed the impressions producing taste to the brain. Taste is now, however, considered due to a branch of the fifth pair of nerves, called the *gustatory*, and that the ninth pair merely bring the tongue into connection with the surrounding parts.

As mentioned in the case of the organs of animal life, the tongue is double, being formed of two distinct portions, joined together at the sides. Cases of paralysis have occurred in which one side of the tongue was incapable of motion, while the other moved as usual, dragging its fellow as a dead weight to follow its motions. Instances are known where the adhesive band that joins the sides became weakened, so that the parts separated, producing a forked appearance. The gustatory branch of the fifth pair terminates in little papillæ, which stud the surface of the tongue, giving it a rough appearance; it is said that they lengthen and become erect in the act of tasting. Taste in man, as in the lower animals, seems intended as a guide in the selection of food, but the habitual use of stimulants and highly spiced food deadens its sensibility. It is a bad sign to see persons fond of pickles, lemons, and similar articles, as it shows that they have so injured, by improper living, the natural function of the papillæ, that no relish accompanies simple healthy diet, and a strong stimulant is required to excite the taste. Reformed epicures have declared that they have derived more pleasure from eating bread and milk than they ever did from their most luxurious feasts in former times. Such acute perception can only be had by strictly obeying the natural laws. A story is told of two men tasting old wine just drawn from a hogshead; both pronounced it very superior, but one said he discerned in it the taste of leather, and the other of iron. On decanting the liquid a small key was found at the bottom of the hogshead tied to a leathern thong.

The tenth pair, or pneumogastric (pertaining to the lungs and stomach), come off from the brain very near the ninth. Their threads are extensively distributed to the parts about the throat, heart, lungs, and stomach. Some of its filaments are endowed with sensation, and some with motion.

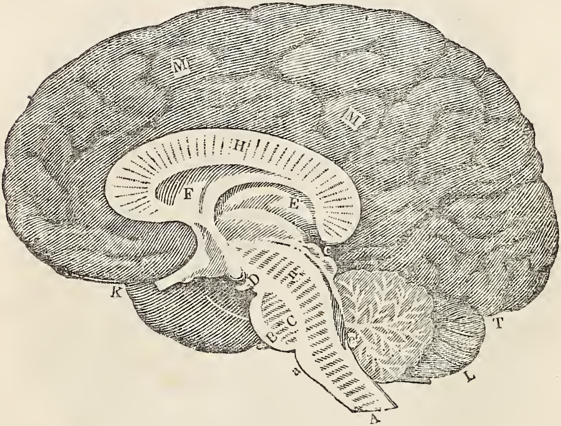
The eleventh pair, or spinal accessory, connects with the ninth and tenth pair, and are distributed to the muscles of the neck. They originate from what Sir Charles Bell called the respiratory tract.

The twelfth pair, or hypo-glossal (under the tongue) nerves, goes to the muscles of the tongue to endow it with motive power.



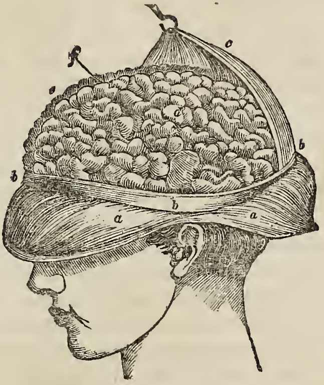
SECTION OF LOWER SURFACE OF THE BRAIN.

The cerebellum C, or smaller brain, rises from beyond the medulla oblongata; it is about one seventh the size of the cerebrum, or larger brain; its gray matter, like the latter, lies externally, and the internal white portion is so arranged as to resemble a tree and branches; a strong, tight membrane continuous with the dura mater separates it from the cerebrum, so that the weight of the latter does not rest upon it. The dura mater also sends down a strong process, shaped like a scythe, between the hemispheres of the brain, or, rather, between the two brains, for the same purpose, that of not allowing them to press upon each other. Each hemisphere, or brain, is divided into three lobes: B B shows the front lobes; E E shows the mass of white nervous matter connecting the brains at their base, and situated about the middle lobes; part of the back lobes is hid by the cerebellum. S shows the PINEAL BODY with its front cords. The other letters refer to the ganglia and their connecting masses, and need not be mentioned here, as our object is only to give a general view of the parts.



THE CORPUS CALLOSUM.

This engraving gives a side view of many of the same parts. H is the corpus callosum shown by E in the preceding engraving; F is another connecting link of nervous matter between the brains; J shows the separation of the larger and smaller brains and their relative size; M M the right hemisphere; B C the pons variolii; K the optic nerve, and A the spinal marrow



VIEW OF THE BRAIN.

a shows the scalp, or covering, of the skullcap turned down, the part cut off by the American Indians in their warfare as a trophy; *b* the sawed edge of the bones of the skull; *c* the dura mater held up by a hook; *e* the superior edge of the right hemisphere; *f* the fissure, or dividing line, between the two hemispheres.

The great intercostal (relating to the parts between the ribs) nerve is formed by branches of the fifth and sixth pair uniting into one common trunk; it then passes downward, receiving and giving off threads to the numerous organs, ganglia, and plexuses, and seems the great connecting link of the whole.

The nerves of hearing, smell, and sight send off no filaments, and receive no impressions separate from their special offices; the other cranial nerves frequently connect with each other.

Four times the quantity of blood is sent to the brain in proportion to its size than to any other part of the body. It is supposed that this blood is used in secreting the nervous fluid, the most highly organized product of the system, and by means of which, through the nerves, it holds communication with the external world. Some have thought that the nerves carry messages by vibrating; but on tying a nerve its function instantly ceases, though it is as capable of vibration as before.

It is probable that the gray matter of the brain continually secretes this fluid, but the demand is greater than the supply in our waking moments. As long as it is plentiful we not only receive impressions from the senses, but also think with ease. Gradually, however, it is exhausted; the optic nerve then becomes insensible to the stimulus of light, and the eyelids close; the auditory nerve to sound and hearing ceases; the other special senses fail in turn; feeling is suspended as well as voluntary motion; the body assumes a recumbent position, and sleep ensues to allow for the accumulation of a fresh supply.

When we overwork any organ we induce injury to its structure, more or less great as we exceed its natural rate of working; thus it is well to obey the first symptoms of fatigue in the evening and retire early; on this account one hour of sleep before midnight is worth two after it, as it prevents excessive and strained working of the function of the brain. There is but little danger of insanity wherever the sleep is regular and refreshing.

Mental exercise wears out a person much sooner than bodily exertion; and the hard student requires more sleep than the laborer or mechanic; if it is not taken, insanity, or else a total breaking down of mental power, will inevitably result. It is a mistaken notion that Napoleon, who was illustrious for the energy and power of his mind, did not take more than five hours' sleep. His secretary, Bourrienne, assures us that he habitually took seven, and a nap in the afternoon besides.

A sound mind in a healthy body is justly considered the greatest of earthly blessings, and unless the system is in a good condition we can not obtain the full power of the mind. Every unhealthy action in any of the organs is transmitted by the nerves to the brain and disturbs its working, and this should make us doubly careful in obeying the laws of Hygiene. Children at school who show signs of much promise are often stimulated by their parents and teachers to undue exertion; play hours are neglected; the function of the brain is overstrained; the diseased organs still further increase the trouble by their sympathetic action, and idiocy or death is the sure ending. Children who testify uncommon power of mind should be especially cared for in the matter of exercise, sleep, and bodily development; and the house of the soul first insured proper attention, no danger will follow the free play of the faculties.

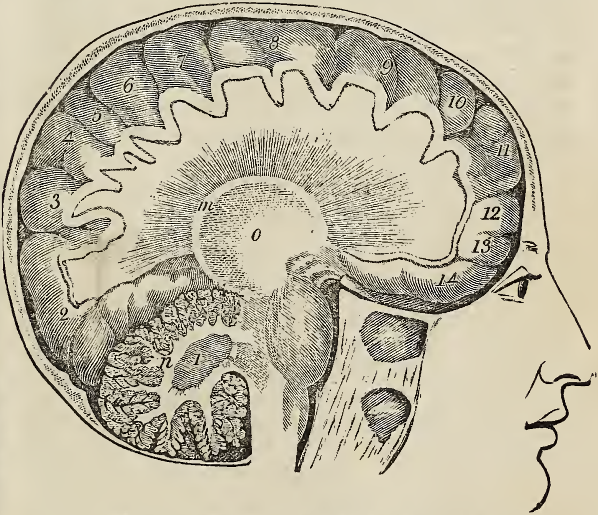
The brain, although the organ of sensation for the rest of the body, can have its own substance sliced and removed without causing pain. If the impressions do not come by means of the special nerves, whose function it is to convey them, no notice is taken by consciousness. When consciousness recognizes a message carried by the nerves, it is called a *sensation;* when referred to the object producing it a *perception;* the memory of this, when the object that produced it is absent, is termed a *conception.* It sometimes happens that the conception, when very intense and vivid, reacts on the nerve that at first conveyed its impression, and the effect on consciousness is the same as if it were a fresh perception. This is called reflex action, and its principle is used to explain ghost-seeing and similar phenomena, where persons have fancied they really beheld the images of absent friends, and conversed with them. Few of us but have been startled by suddenly hearing voices addressed to us when alone, and sometimes by a momentary perception of persons and things that our judgment told us were not present.

The soul is insulated, and can only hold communication with the external world by means of the fluid in the nerves whose impressions it is forced to receive with perfect confidence; but if these servants become diseased or unfaithful, erroneous messages are conveyed, which the mind acts upon as if true; hence the necessity of two brains, like two eyes and two ears, that if one becomes deranged the other may still work. There have been numerous instances known in which the mind remained clear and entire to the last when one hemisphere has been completely destroyed or disorganized; but the celebrated Solly states, "that there are no cases on record in which the mental faculties have remained undisturbed when the disorganization has extended to both sides of the brain."

Dr. Wigans explains insanity by the double brains. He teaches that when the structure of one is a little diseased, the correction of its erroneous impressions is made by the other. But if the malady progresses, it occasionally obtains the upper hand, and thus there are intervals of raving madness. After a time both brains become affected and there are no lucid intervals, the insanity being incurable. While one hemisphere remains undisturbed the madman is able to carry on a conversation between his brains.

Cases are on record where persons have forgotten all they ever knew and had to begin learning again, even to the letters of the alphabet; but on a sudden all their former knowledge would be restored. The double brain explains such instances. There is an account of an Irish gentleman, whose forehead was far higher on the right side than on the left, and it caused him much sorrow that with this left side he could never think. The necessity of having a common center to which impressions from both brains could converge, has led physiologists to locate the seat of the soul in various portions of the brain. The most probable opinion of this kind seems that of Descartes, who decided on the PINEAL BODY as the throne of the mind; it is central in position, and connected with the most important parts of the brain by nervous threads.

Phrenology at the present day teaches that the mind consists of forty-two faculties, and assigns to each faculty a distinct material organ for its manifestation; and that in proportion to the size of an organ is the power of its faculty increased. As far as the lower faculties are concerned, which man has in common with the animal creation, there seems little objection to this view of the subject, more especially as it throws great light on the arrangement of the ganglia of the brain.



PERPENDICULAR SECTION OF THE BRAIN AND SKULL

This engraving gives a rather fanciful, although for the most part truthful representation of the interior of the brain; the two tables of the skullcap are shown, with the cells between. Rising up from the neck is the spinal marrow, which is enlarged by the addition of ganglia to form the medulla oblongata; behind the latter is the cerebellum *n* showing its branchy appearance, and fig. 1 the ganglion in its center; the other numbers refer to the convolutions of gray matter, each of which has the name of a distinct faculty assigned to it by phrenologists; *o* shows one of the inferior ganglia, and *m* the supposed appearance of the fibers radiating from it.

In the writings of Aristotle we find the front ventricle of the brain assigned as the seat of *common* sense, the second ventricle as the seat of imagination, judgment, and reflection, and the third ventricle as that of memory. Gordon, in 1296, gives nearly the same account. A head, by Dolci, in 1562, has the head mapped out in various faculties, and the limits assigned to each. Dr. Gall gives an account of many of these freaks of philosophers, for they are entitled to no better name, as fancy evidently governed the whole arrangement. Gall's method was immeasurably superior, and founded on the result of an extensive series of observations from nature.

CHAPTER X.

THE TEMPERAMENTS AND RACES OF MEN.

Doctrines of the Ancients—Teachings of Hippocrates—Lymphatic Temperament—Sanguine Temperament—Bilious Temperament—Nervous Temperament—Better System—Nutritive, Motive, and Mental Temperaments—Change and Nurture of Temperaments—National Distinctions—Noah and his three Sons—White Man—Brown Man—Black Man—Tawny Man—Red Man—All Nations made of one Blood—Causes of Diversity—Climates—Food—Manner of Life—Hereditary Transmission of Disease—Conclusion of the Argument.

The ancients, who knew but little of the true philosophy of the mind, supposed that the various tempers and dispositions of men arose from the greater or less quantity of some particular fluid in the body predominating over the rest. Thus *choler* is the Greek term for bile, and they thought this secretion prevailed in all those of a quick temper and prone to anger from slight causes; hence our word choleric applied to persons of the bilious temperament. Melancholy signifies literally in Greek black bile, that they supposed the spleen to secrete, and too great an amount of it to produce a sad, joyless disposition. The word phlegmatic means of a thin, watery nature, and to the predominance of the serous secretion they ascribed habitual indolence and inability to think. Sanguine is a Latin term, and has reference to the blood which, when pure and in abundance, they considered as imparting health of system and buoyancy of spirits.

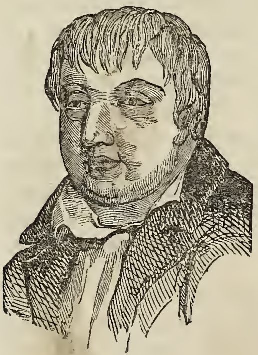
Hippocrates is the oldest writer who has given a description of the temperaments; and although the moderns have varied and enlarged his classification, yet the terms even now form a part of the English language, as just mentioned. The word temperament is from *tempero*, to mix, in allusion to the mixing of the humors or juices of the system. Mankind are generally arranged by writers on this subject in four classes, to which the names of Lymphatic, Sanguine, Bilious, and Nervous are given respectively.

The LYMPHATIC temperament is defined as that in which the watery fluids predominate. The secretion from the cellular tissue is very abundant. The hair is straight, of a light color, and the skin pale. The body is very rounding, and rather swelled in every part; when pressed upon by the finger a pit is made which does not readily fill up. The muscles are soft and deficient in strength. There is but little disposition to exert either body or mind. Work is performed slowly and languidly, and without much power of endurance. The mental faculties are feeble in their manifestations and are exerted mainly on objects of sense. The person has a sleepy, contented look, and is happy if let alone and not disturbed by cares or labor.

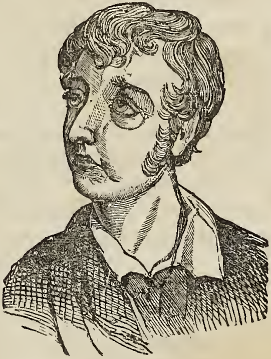
The SANGUINE temperament gives a plump, well-defined form, ruddy complexion, hair inclined to chestnut, and often curly. It is in this division that sensual beauty, or that which pertains to color and symmetry, is found. There is but slight inclination or capability for intense exertion, whether of body or mind. This character succeeds best in the minor business of life, especially when most of the work is out of doors.

The BILIOUS temperament has dark hair, eyes, and skin, extreme hardness of muscles, which are strongly developed, and give the person a harsh outline, from the want of cellular tissue. An intense, burning energy is shown in whatever is undertaken; every thing is urged to its utmost speed; great daring is manifested. This temperament is never at rest, or allows others to be so; always projecting and persevering until the end is accomplished. It gives the conspirators and revolutionizers of the world.

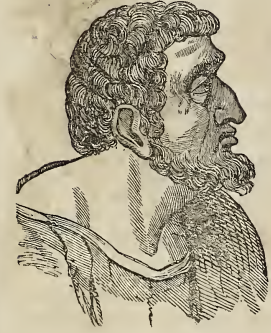
The Nervous temperament is exhibited by great delicacy of constitution; fine skin and hair, both generally light; soft muscles; excitable disposition; quick, abrupt movements, and brilliant mental powers. It gives the poets and orators of the world.



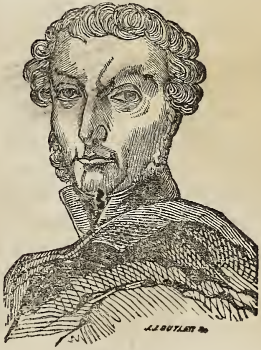
LYMPHATIC.



SANGUINE.



BILIOUS.


J.J. BUTLER Sc.

NERVOUS.

A new system has lately been proposed, more true to nature, and, as such, allows each to be more readily distinguished. It divides the body into the head, chest, and abdomen, and gives the name of the part that is largest to the temperament. Except the names, which we have changed for what we think more appropriate ones, it is as follows :

The NUTRITIVE temperament answering to the old Sanguine. It has a fully developed abdomen, almost perfect digestion, every part rounded and the flesh moderately firm, a reddish cast of hair and countenance, and eyes inclining to blue. There is a fair share of energy both of mind and body, but not much power of intense exertion. The Lymphatic temperament, as it is called, is evidently a degeneration of the Nutritive, and should be obviated by muscular exertion and study, which conduct, if persevered in, will effectually remedy this unfortunate habit of body.

The MOTIVE temperament, like the Bilious of some writers, has the chest very largely developed, the muscles hard and powerful, skin and hair very dark, and great capacity for long and continued endurance. By itself it generally shows little power of mind, but when it shares equally with the Mental, displays such men as Alexander, Cromwell, and Napoleon.

The MENTAL temperament has the brain very large in proportion to the rest of the body; the entire texture of the system is delicate, and there is great susceptibility to impressions of every kind. The mental powers are bright and flashing, and constantly in exercise. The great drain upon the entire organism made by the brain causes the other organs to suffer, and there is much liability to disease, so that this peculiar constitution is rarely seen in good health. Whoever possesses it should, by strict observance of the laws of Hygiene, endeavor to obtain as much of the Motive or Moving temperament as possible, and they will thereby not only retain their brilliancy for a longer period, but also give their works more depth and power of learning.

The temperaments are rarely observed pure, and it is undesirable that they should be so. It is their due proportion that makes the perfect individual. The Nutritive is necessary for health, the Motive for energy, and the Mental for intellectual power. The defect is more or less great according as they are unequally balanced; and due attention should be paid to each to make a well-toned and efficient character.

But these are not the only differences among mankind; not only has each country its own characteristics to distinguish its inhabitants from those of others, but we find the long-continued influences of food, climate, and habits produce much greater, and we rise from temperaments to national peculiarities, until we finally ascend to races, or varieties of the human species.

When Noah and his three sons came down from Ararat, after the Deluge, and made a division of the earth among themselves, it is generally considered that to Japhet, the eldest, was given, as his portion, Europe and the isles of the sea; to Shem, Asia; and to Ham, Africa. At first their descendants remained together, until the confusion of tongues forced them to disperse, when they separated, traveling toward their several allotments, each division, as their numbers increased, overrunning their inheritance.

The children of Japhet spread onward into Europe from the Caucasian chain of mountains, and on that account have received the name of the Caucasian variety. Dr. Good remarks that on the spot of ground where man was created, where he received the breath of life, and arose in the image of his Maker, the die has not yet lost its divine impress, as far as relates to beauty and exterior grace, for there we still meet, and in all ages have met, the most exquisite models of beauty and symmetry.

WHITE MAN.

The European or Caucasian variety, sometimes called, from the complexion, the WHITE MAN, has cheeks more or less red, the head roundish, the face oval, with features distinct and prominent, and hair and eyes variable in color, although inclining to the lighter shades.

BROWN MAN.

Shem's children are known as the Asiatic race, and his type as the BROWN MAN; the complexion is of a dark olive color, the head square, the cheek bones wide apart, the face flat, the eyes small and, like the hair, black, the latter wanting the abundance of the European.

BLACK MAN.

Ham's descendants are known as the African race, and their type is the BLACK MAN; the head is narrow, with a receding forehead; the nose is flattened, and almost continuous with the cheeks; the lower part of the face projects forward, and the hair is black and woolly.

We have described the extremes of each type; but of course there are all intermediate grades, where they shade into each other, as a necessity of their common origin, and where the same kind of habits, location, and climate would produce the same results. Among some of them there is occasionally a partial return to the primitive types, for fair skins have been observed in some of the American Indians, and Captain Cook saw, as he tells us, hundreds of European faces among the natives of the Friendly Islands, and also not a few genuine Roman noses.

TAWNY MAN.

Some physiologists consider the distinctions sufficiently marked to form two other varieties in addition to those described. The first of these is the Malay variety, or Tawny Man, the resident of Oceanica; the complexion is of a mahogany color; the head rather square, narrowed at its upper part, with the lower portion of the forehead broad; the hair harsh and coarse, long, with a tendency to curl, and black. Some think that here is the medium line between the European and the African.

RED MAN.

The second of these varieties is the American Indian, or Red Man, who is evidently of Tartar origin, with some modifications induced by climate, the main differences consisting in the cheek bones being less prominent, and the face not so flat as in the true Asiatic; like the latter, the eyes are sunken, and the hair straight and black. The Tartar could enter North America in former times by its connection with Asia where Bhering's Straits are now; for that that communication was formerly possible is evident from the great quantity of animals' bones found on each side of the Straits at the present time.

We are told in the Scriptures "that God hath made of ONE BLOOD all nations of men, for to dwell on the face of the earth;" but some writers, at various times, and even in our own day, have doubted this statement, and contend that there were as many different families created at the beginning as there are separate races of men. Although their arguments have been completely controverted again and again as often as they have been brought forward, yet the same assertions, supported by the same facts, reappear occasionally, regardless or unknowing of the confutation. To enable the student properly to meet such, we will comment on the four chief causes of diversity, following Dr. Good, who has taken much pains in compiling from the authorities on the subject. These four causes are CLIMATE, FOOD, MANNER OF LIFE, and HEREDITARY AFFECTIONS, or DISEASES.

CLIMATE principally affects the animal frame by acting on the color of the skin and the extent of the stature. As color has before been considered in connection with the skin, it need not be repeated. A moderate degree of heat is favorable to strength and size of body, while an immoderate degree of it weakens and finally injures the development. The tallest tribes known live in the warmer portions of the temperate zones, and the smallest in countries like Greenland. There are all diversities of stature, from four feet to seven.

FOOD affects the system by its quantity, quality, and mode of preparation. It induces all grades of fineness and coarseness. If scanty and innutritious it prevents full development, and if too abundant and rich in kind fills out the body and induces a gross texture. Every-day observation, both on man and the lower animals, furnishes proofs sufficient of these facts. Huber, by feeding what is termed a neuter bee on royal diet, changed it into a full-formed queen.

MANNER OF LIFE induces the most important changes in the entire organized world. The wild flower, when placed in the garden, is made to become double by the change of its stamens into petals. Our most luscious and healthy fruits have been originally derived from bitter, unwholesome stocks, and we are indebted to cultivation for their improvement. Among the lower animals its effects may be seen by comparing the difference between the domesticated cat and dog, and the same animals when allowed to run wild and remain free from the control of man. Man, by changing his business, rapidly alters his temperament; the student is as certain to acquire the Mental, as the farmer or mechanic the Motive.

Hereditary Predispositions. By the certain operations of the organic laws, the father transmits his own peculiarities to his children; not only those which he has inherited himself, but also those which he has acquired. In this way it is in his power not only to improve but to deteriorate his race. A man may justly be proud of illustrious ancestors, for there is a strong presumption that he has inherited much of their good qualities, and it should make him especially careful not to suffer them to degenerate in his person, for he is thereby doubly disgraced. It is well known that a predisposition to consumption or insanity runs in many families. Long lines of the same name are known with five fingers and a thumb on each hand, and six toes on each foot. The same is observed in the lower animals; hornless sheep produce an equally hornless offspring; and cats and dogs who have lost their tails often mark their progeny in the same manner. Swine are found with both solid and cloven hoofs. By means of this law of hereditary descent the effects of the other causes, as climate, food, and manner of life, together with accidents, are stereotyped in the descendants of living creatures; and it is not difficult to show that a single pair at first are adequate to account for all the diverse races and nations of mankind.

"How absurd, then," says Dr. Good, "to contend that the distinctions in the different varieties of the human race must have proceeded from a plurality in the species, while we are compelled to admit that distinctions of a similar kind, but much more numerous and extravagant, have proceeded from a single species in other animals."

CHAPTER XI.

THE LAWS OF HYGIENE AND EDUCATION.

Hygeia, one of the four Daughters of Esculapius—Laws of Hygiene extend through the whole Period of Life—Hygiene of Infants—Hygiene of the School-room—Uses of Calisthenics—Insulation of the Soul—Connection of Mental Philosophy with Physiology—Outline of Education—Use of Words—The Cultivation of the Perceptive Intellect—Cultivation of the Memory—Teaching Geography—Teaching Mental Philosophy—Cultivation of the Reflective Intellect—Difference of the Senses—Importance of Studying Music and the Fine Arts as a Link to Profound Science—Gradation of Studies—End of School Education—Discipline—Training of the Moral Faculties—Magnifying Physiology—Proper Education—Danger of Neglecting it and Advantages of Right Training.

Hygeia was one of the four daughters of Esculapius, and was elevated by the ancients to the rank of goddess of health. It was thought to be the duty of the physician to prevent disease as well as to cure it, and a full expression was given to this sentiment by placing the daughter with the father on the same monument; several of the works of art now remaining have both figures thus represented. Of late years the moderns, equally with the ancients, have felt the necessity of the proper teaching and observance of the laws of health, and they have become a distinct branch of medical science under the name of Hygiene.

These laws show the indications of nature, and the danger of deviating from those indications in every period of life, beginning with infancy and ending with the allotted span of human existence. Commencing with the young infant, they show that from the softness of every part, and its inability to bear the least fatigue, it should be allowed as much rest and be handled as little as possible. It will begin of itself to move about and play as soon as its muscles are strong enough to exercise without injury. Only fluids, as milk, are required before the teeth protrude through the gums; but as these appear the diet may gradually change to more solid food. Now is the time to commence the formation of good habits and have regular hours for meals, sleep, and play. The French do not allow pins in the dresses of children; the nurse uses a needle and thread to fasten the clothing, ripping and sewing again as occasion demands. Washed every morning in moderately cold water, limited to the simplest articles of diet, and permitted free exercise in the open air in loose clothes, it grows strong and hardy, and in a few years is old enough to be sent to school with advantage.

Hygeia still continues her supervision, points out the fact that the brain and nervous system are yet very soft and can endure at first only a small degree of exertion, and that they are least strained by directing the child to objects of sense. She shows the morning to be the best time for severe exertion, leaving the lighter studies for the afternoon; that two or three hours' detention in school are enough for young children, as they grow older gradually extending the period to five or six.

The school-room should be in a pleasant location, where the sun may shine into it at all hours of the day, curtains and blinds of course preventing inconvenience to the pupils. It should be thoroughly ventilated and comfortably furnished with seats, so arranged that the feet may touch the floor and backs to rest against. Teachers alternate the exercises to prevent sitting or standing too long at a time, and allow intervals for play spells. In boarding-schools for girls calisthenics form part of the regular course as well as walking, the object being to develop every part of the body. Singing accompanies calisthenics, and they are so taught as to obtain all the benefits of dancing without any of its objectionable features, imparting a graceful carriage and polished manners. For the same object boys practice gymnastics. The rule is to attend first to the body and secondly to the mind, as unless the former is in good condition little can be accomplished with the latter.

As the soul in this life never works except through the medium of the organism with which it is connected, it follows that a thorough knowledge of Physiology is absolutely necessary to a right comprehension of mental philosophy. The teacher must understand both to perform his duties successfully, and as far as lies in his power insure his pupils sound, well-educated minds in healthy bodies. It is considered, therefore, that a simple outline of education, following the indications of nature, is not out of place in a work of this character.

Children can only be taught the right construction of words in sentences by imitation; when the expression is erroneous, the parent or teacher should correct and make them repeat the whole over again. They receive at an early age an impress that lasts through life, and due attention to this matter in youth will not only prevent the necessity of much unlearning when they are able to appreciate the rules of grammar, but also lay a sure foundation for elegant writing and conversation in all future time.

The shapes, outlines, and shadows of objects are readily understood by children, and in regular order to these should be taught their size, proportions, weight, and colors; then the practical meaning of the maxim, "A place for every thing and every thing in its place," and the importance of orderly succession and arrangement; the principles of numbers may then be taught, and tables for the first four rules committed to memory, taking care to connect with the numbers objects of sense, as four men and six men, three apples from eight apples, how many eyes ten children have, and if twelve pears were divided among six children how many for each, illustrating by the real objects themselves or by pictures, for it is in vain to try to give them abstract ideas.

The study of the direction of things and places and the points of the compass succeeds, and with these are to be connected primary geography and history. They should begin with the rooms and passages in their houses and school; then the roads or streets leading to each, and their terminations; the nearest river, from its source to its mouth; the township, county, state, political division, and continent; drawing maps of each as they proceed, connecting with the places their history, and especially committing the dates of the principal events to memory. In this manner, by commencing at home, they will finally embrace the globe, and thus prepared to leave their own sphere and extend their researches to other worlds.

Simple tunes should be taught by ear as soon as words can be distinctly pronounced, as singing enables them to vary the voice and read and talk better than they otherwise could do. The elementary sounds of the language may be taught in connection with the letters; for the sooner they find out that the *name* of a letter and its *sound* are different things, the better will their enunciation become. Their constructive powers should be early exercised in drawing and penmanship. Reading, writing, and arithmetic must be continued all the way upward, for well grounded in these, they are able, if thrown on their own resources, to learn all the rest.

Children can understand the first principles of mental philosophy much sooner than is generally supposed, and such information insures greater rapidity and thoroughness of progress. They see the importance of accurate perceptions, or mental daguerreotypes, so that the after conceptions may be clear and distinct, making the memory resemble a gallery of pictures by great artists, and not the imperfect attempts and confused daubs of a tyro. They should be taught that memory is the great storehouse of the mind, into which all sensations and perceptions are received, and where they forever remain; but that to obtain a command over them so as to be able to recall them at will they must be often and regularly brought before consciousness; and for this purpose their studies require frequent reviewal. For the same object they may be encouraged in conversation on the subjects of their lessons, and explaining to one another difficult matters in them. This is a good means of keeping up classes to a uniform standard; all of them soon find that the more knowledge they impart the more they retain, and that the fountain increases in depth and purity by dispensing its waters.

Every pupil has now a large store of ideas, and these so linked together in trains of association that they can be most usefully and readily drawn upon; and the time has arrived when they should be compared together, that their relations may be discovered, whether of cause and effect or incongruity; the process of generalizing will be found easy enough. As each successive step has been taken only after a review and more thorough examination of all the preceding ones, it is presumed that grammar, mathematics, the natural sciences, and the languages, together with their related studies, are now understood, and that the scholar is preparing for the more profound philosophy.

The mind, as mentioned in the account of the nervous system, is entirely insulated from the external world, and can hold no communication with it except by means of the senses; but in these there is a great difference in their mode of conveying knowledge. In all cases of touching, tasting, and smelling we are directly aware of the medium, so that the pleasures derived from these are of a purely sensual character, and referable to the objects producing them. But it is otherwise with respect to seeing and hearing—the medium is not felt, and the effects are referred to the mind alone. This might be inferred from the physiology of the optic and auditory nerves, which do not communicate with the other nerves, and refuse to convey any but their own peculiar impressions. The same is true of the olfactory, which holds a medium rank between the first two and the last two.

Upon this account, as Lord Kames observes, seeing and hearing are thought to be more refined and spiritual, and are elevated above the others, forming the connecting link between the pure intelligence and the outward world. "Their mixed nature and middle place," says he, "between organic and intellectual pleasures, qualify them to associate with both. Beauty heightens all the organic feelings as well as the intellectual; harmony, although it aspires to inflame devotion, does not disdain to improve the relish of a banquet." Hence the cultivation of music, poetry, and the fine arts leads the mind, without abruptness and without repugnance, to the most profound philosophy, and does away with all the horror with which the latter is viewed by those who have been prematurely hurried into its depths without the really necessary preparatory discipline.

"Our first perceptions," says Lord Kames, "are of external objects, and our first attachments are to them. Organic pleasures take the lead; but the mind gradually ripening, relishes more and more the pleasures of the eye and ear, which approach the purely mental without exhausting the spirits; and exceed the purely sensual without danger of satiety. The pleasures of the eye and ear have accordingly a natural aptitude to draw us from the immoderate gratification of sensual appetite; and the mind once accustomed to enjoy a variety of external objects without being sensible of the organic impression is prepared for enjoying internal objects where there can not be an organic impression. Thus the Author of nature, by qualifying the human mind for a succession of enjoyments, from low to high, leads it by gentle steps from the most groveling corporeal pleasures, for which it is fitted in the beginning of life, to those refined and sublime pleasures that are suited to its maturity."

The previous studies of the pupil have had a two-fold advantage, for not only has a vast store of information been gathered in the proper manner, but the faculties in collecting and arranging this store have become powerful and distinctly marked, so that consciousness can recognize their individual workings. The pupil begins to perceive that as he has in a measure exhausted the external world, he has ideas which could never have proceeded from a material origin, and by reflecting and meditating on these, a new world within himself gradually unfolds its wonders to his delight and astonishment. Guided to this stage of progress, the scholar stands on the same platform with his teacher and has become his peer. He no longer needs a master, and, as a member of the Republic of Literature, is fully able to acquire knowledge for himself and impart it to others.

In the mere outline just given, nothing has been said of discipline; but no trouble need be feared in that respect after the pupil is once interested in his lessons. To make discipline a mechanical form is to injure the mind, but to connect it with the moral sensibilities is really to train them and gradually develop and perfect all the faculties as nature intended, by the constitution of the mind. It is believed that where the object can not be attained in this way it will be valueless, nay, even pernicious, in the formation of character.

"The fear of the Lord is the beginning of wisdom," and without first laying this foundation, teachers will toil in vain, as their pupils can not become truly wise. And rightly managed it is no difficult matter. The minds of the young are facile and yielding, proverbially open to the reception of impressions, of which the earliest are the most durable. It was told the Israelites in relation to the commands of the Lord, "Thou shalt teach these things diligently unto thy children, and thou shalt talk of them when thou sittest in thy house, and when thou walkest by the way, and when thou liest down, and when thou risest up." This command in our own day is especially obligatory on the teacher. as his opportunities of obeying it are unequaled.

Occasions for directing the attention of the pupils to God's Word are constantly occurring in the lessons. While reading history, reference can be made to prophecy and its fulfillment, and thus the pupil becomes a witness of what is considered by some writers the most convincing of all miracles to attest the veracity of Scripture, as the predictions can be seen, as it were, taking effect under our own eyes. For astronomy, texts may be shown telling us that "He hath made the round world so sure that it can not be moved," and that "He hangeth the earth on nothing." For botany, we find the three grand divisions of the vegetable kingdom made by Moses recognized by science at the present day.

For natural philosophy, texts can be quoted showing that "He hath given to the air its weight," and that "All the rivers run into the sea, and yet the sea is not full; into the place from whence the rivers come, thither do they return again." While studying the atomic theory in chemistry, we read its conformation in the Word, where it is revealed that the Almighty Architect has literally adjusted every thing by weight and measure; that He has measured the waters, and meted out the heavens, accurately comprehended the dust of the earth, weighed the mountains in scales, and the hills in a balance. These texts offer but a small specimen of what can be obtained from Holy Writ for this object.

Thus brought in constant contact with the truths of Scripture and habituated to its study, they not only find it an incidental means of confirming knowledge derived from other sources, but soon grow to regard it as a rule of conduct. They soon begin to realize in their own experience that the entrance of God's Word gives light and makes wise the simple in heart; and that the "Voice that rolls the stars along speaks all the promises." It is not long before they are able to appreciate the words of Coleridge, that "An hour passed in sincere and earnest prayer, or in conflict with and conquest over one single passion or subtle bosom sin, will teach more of thought and more effectually awaken the faculty and form the habit of reflection than a year's study in the schools without them."

Peace of mind and cheerfulness are the consequences of such discipline. Obedience and respect are freely yielded to their teachers, and there is shown a sincere desire to act up to their duties on all points. As the character is gradually forming, habit makes self-denial easy. The things of time are studied in their true contrast with those of eternity. They are aware that He who formed the lily and lent its perfume to the rose has not given them perceptions of the beautiful in vain, and that taste is to be exercised in both dress and deportment; but they also know that the "appareling of the spirit" is to be mainly sought after, and, with manners founded on true Christian models, are not ashamed to be singular in doing right.

By connecting Physiology with the study of mental philosophy, we magnify the former, and show its importance throughout the entire educational course; and, also, lay the proper stress on the teaching of music and the fine arts, as a preparation for entering the regions of abstruse science.

Right education is a training of the pupils so as to fit them for the active business of after life. The greater part of their studies should have direct application to their future employments, for it is not so much what they are learning as how it is taught that disciplines their minds. This fact is too often lost sight of, and the period of schooling kept distinct from that of active duties. Remaining at school until the last moment, they are abruptly plunged into occupations for which they are unfitted by habit and association, and, therefore, no wonder distasteful. This constant attention to books alone is erroneous, even for the pure scholar who intends devoting his life entirely to study. Of how many such has it been said, "that they had every kind of sense but common sense;" their example in this respect is a bad one, and not only do they lose much of the influence they might exert for good on those around them, but their ignorance of ordinary matters occasions great inconvenience to themselves.

To remedy this, the girl should have household affairs explained to her as soon as she is able to understand them, and be required to take her share of the work and management in proportion as her powers expand. She will thus have duties at home as well as at school; each will be a change and relief to the other, and the taste will be acquired for its performance when the whole charge of home devolves upon her. It will make her knowledge practical, and form the habit of combining study with work, so that her books will not be laid down, and their contents forgotten, after she leaves school.

The boy, in the same manner, should begin early to take a share, either in his father's business, or in that for which he is destined, gradually performing more and more as he becomes older. He will understand his studies better, as there will be many opportunities of applying them, and it will teach him their value as a means of preparation. It is probable that this course would cause principles of science to be brought to bear with advantage on branches of business where improvement is not thought of at present, and thus, by combining science and art in every employment, equalize the dignity of all. Finally, when, like the girl, the school or college doors close upon him, and he devotes the greater part of his energies to his particular calling, habit alone, if nothing else, will carry him onward to spend his leisure hours in literary employments.

The diffusion of the laws of Hygiene will cause the dwelling-house, the office, and the workshop to be well constructed, in accordance with their requirements; the personal habits to conform also; the mechanic to devote a portion of his evenings to faithful study; and the student a share of his time to hardy exercise; for both will know that the whole system requires full development to allow even the proper working of particular organs. Sound, well-educated minds in healthy bodies will be the motto of each, and a thorough acquaintance with the laws necessary to effect these objects will make the motto realized. And with a people whose masses are thus instructed and impelled, the past prosperity of our country will scarcely be worthy of comparison with its future greatness.

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